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SPECIAL ANATOMY

AND

HISTOLOGY.

BY

WILLIAM E. HORNER, M.D.,

PROFESSOR OF ANATOMY, UNIVERSITY OF PENNSYLVANIA; SENIOR SURGEON, SAINT JOSEPH'S HOSPITAL; MEMBER OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA; ETC. ETC.

Multum adhuc restat operis, multumque restabit, nec ulli nato, post mille sæcula præcluditur occasio aliquid adjiciendi.

SENECA, EPIST.

EIGHTH EDITION.

ILLUSTRATED WITH ANATOMICAL FIGURES.

IN TWO VOLUMES.

VOL. II.

PHILADELPHIA:

BLANCHARD AND LEA.

1851.

PHILADELPHIA:
T. K. AND P. G. COLLINS, PRINTERS.

SPECIAL

ANATOMY AND HISTOLOGY.

BOOK IV.

PART II.

GLANDS AND THE ORGANS OF ASSIMILATION.

CHAPTER I.

PROLEGOMENA ON THE STRUCTURE OF GLANDS.

The intimate structure of glands was but imperfectly attended to previously to the celebrated Malpighi, who, in the year 1665, presented to the world his work entitled "Exercitationes de Structura Viscerum." Till his time, the most minute inquiry had gone but little beyond the point of observation, that glands consisted (as an ultimate arrangement of their particles) in small granular bodies called Acini, from their being clustered like grapes or berries, growing very closely together around a common stem and its branches.

The simple idea, propounded by Malpighi, is, that each acinus being a gland of itself, consists of minute spheroidal sacs, which receive the secretion from the blood-vessels. Darwin, at a much later period, modified this idea by advancing that the change occurred in the spheroidal sacs themselves. The celebrated Ruysch having improved much the art of injection, was enabled to show in his preparations, that what Malpighi considered as sacs or follicles, were really formed of convoluted blood-vessels. He hence adopted the opinion, false in itself, that the substance proper of glands is formed wholly of blood-vessels, and that the minute branches of the latter terminate by direct inosculation with the ducts of the glands. As another step in this inquiry, Mascagni and Cruikshank showed that the secreting canals in the mammary glands commence in the form of cells; and Professor Weber discovered the same feature to exist in the structure of the salivary glands of birds and mammalia, and of the pancreas of birds.

The existing state of opinions on this interesting subject is derived

from J. Müller, Professor of Anatomy, Berlin, who[1] has announced as the result of his inquiries on the structure of the secreting canals in all kinds of secreting glands, that such canals are found everywhere to form an independent system of tubes. "That, whether they be convoluted, as in the kidneys and testes, or ramified in an arborescent form, as in the liver and salivary glands—whether they terminate by twig-like cœca, as in the liver—or in grape-like clusters of cells, as in the salivary glands, pancreas, and mammary glands—their only connection with the blood-vessels in all cases, consists in the latter ramifying and forming a capillary net-work on their walls and in their interstices: and that the finest secreting tubes, namely, those of the liver and kidneys, are always several times larger in diameter than the minute ramifications of the arteries and the veins."

This doctrine is, therefore, a modified resumption of the more ancient one of Malpighi, and claims merely for the entire surface of secreting tubes what Malpighi thought to belong exclusively to their incipient extremities. The leading argument in its favor being, that in every case there is a minute vascular net-work of capillaries discernible on the parietes of these canals, and whose capillaries are much smaller than the secreting tubes themselves.[2]

Glands of the most simple shape are mere recesses or pouches in the thickness of the membrane or surface to which they belong (*Folliculi*). In some instances they are very superficial, and their bottom is reached through a wide orifice—in other instances their mouths are somewhat contracted like the neck of a bottle—in other cases they have a long and tortuous course (*Tubuli*) as the tubuli seminiferi of the testicle. In most of these modifications of a tubular arrangement, from the shortest to the most elongated, the walls of the tube are not absolutely uniform, but it will be found that there are either partial or cellular dilatations of it, or cœcal-like appendages, in great numbers discharging into it, and placed in varied angular relations to the principal sinus or secreting tube. The stem of a thickly-clustering bunch of grapes, the berries being removed, will represent sufficiently well the mere mechanism of this arrangement.

A form of secreting canal a little more complex is where a large spheroidal dilated sinus exists with tubules, radiating from it (*Folliculi aggregati*) in lines more or less regular; the sinus itself having a large patulous orifice connecting it with the surface upon which it discharges. One of the follicles of the tonsil glands may represent this arrangement. Also the glandulæ linguales on the root of the tongue, which seem to be a mere extension of the lower end of the tonsil gland in the form of an expanded flank, and are not unfrequently directly continuous with the tonsil gland. Another form of this composite canalicular arrangement is when the collection of tubules is more in a line, the branches diverging more slightly from each other (*Folliculi compositi*) and each of those branches again diverging into other branches, and so on successively to their last twigs. The Meibomian glands and the vesiculæ seminales are instances of the linear composite follicle, or tube having

[1] De Gland. Struct. Penit. Leips. 1830; and Physiol. p. 485, London, 1840.
[2] See Capillaries.

but one set of branches. A lactiferous duct is an example of the composite secreting canal, or tube with a numerous and indefinite succession of finer and finer branches, and which end finally in club-like dilatations. Some of these secreting canals end in a divarication of branches resembling the flowering ends of the umbelliferous plants.

Some of the glands present a species of regularity in the order of division of their secretory canals. The principal trunk of the latter gives off at intervals nearly uniform lateral branches; these branches give off with regularity other branches; and the latter again observe the same disposition. This modification is preserved to a remarkable degree in the pancreas, and is also visible in the salivary glands, the lachrymal, and the mammary. In cases of this kind the lobulated condition is very clear, the lobules being rather feebly held in connection with the contiguous ones by loose cellular substance, allowing the lobules to be easily separated from each other by drawing at them. The lobules themselves are ultimately divisible into granules (*glomeruli or acini*) which under the application of the microscope are found to be aggregated cells, surrounded by a fine vascular net-work of capillaries, and making the peripheral end of the most minute secreting canals. The trachea with its division into bronchia, bronchioles, final air tubules, and air vesicles at the end of the latter, represents on a large scale the division which is seen in glands on a small one. An unsettled question is, whether these vesicular terminations are in all cases kept distinct, or whether from a defect in their parietes they do not communicate like the air vesicles of the lungs, and have in that way a tubule common to several. In some instances the ultimate secretory tubules of those ramified ducts are arranged like cœca around the branches of the latter.

Another form of the ramified secreting tube is where there exists no division of the gland into lobules, but it is resolved at once into acini. These acini being formed upon the final divisions of the secretory tube, which rise up in fasciculi, giving a brush-like or penicillous appearance. The liver is an example of the above, it being doubtful whether there is any spheroidal enlargement at the free end of the penicilli.[1]

The glands with successively ramified secreting tubes are the
Lachrymal gland,
Mammary gland,
Salivary glands, as Parotid, Sub-lingual, and Sub-maxillary,
Pancreas,
Liver.

The glands of an almost pure tubular structure and indisposed to ramify, except in a very limited manner, are the
Kidneys,
Testicles.

The Meibomian glands and the Vesiculæ seminales may be considered as a tendency to the same structure, but in a more abbreviated

[1] From *peniculus*, a painter's pencil.

and simple condition; by some they are considered merely as branched follicles.

The summary of the secretory glandular system then is, for it to present itself in the simple short tubular state of shallow depressions, or crypts of a mucous membrane, as in the urethra and bladder: in bottle-shape cavities: in closed lenticular cavities, as Peyer's Glands: in the follicles of the alimentary canal, which are either single or branched: and as thin follicles with a glandular matter or parenchyma, principally vascular, forming a nidus around them, and which follicles may themselves be either simple or branched in some degree.

Fig. 155.

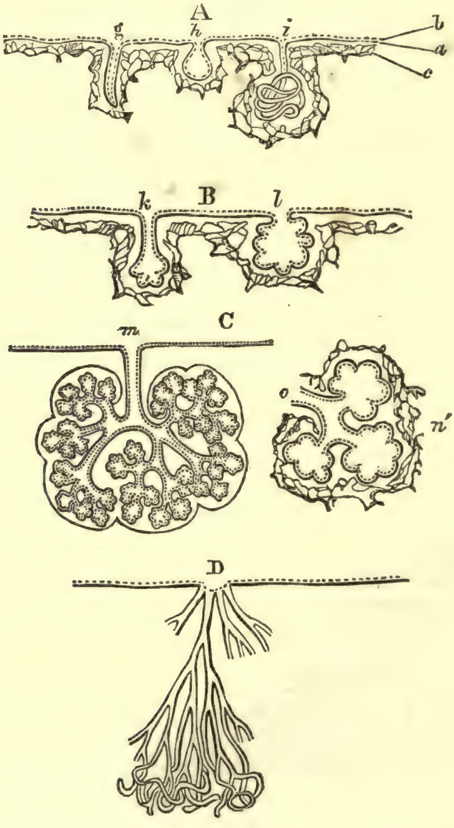


Diagram of Glandular Structure.—A. Simple glands. *a*. Basement membrane. *b*. Epithelial cells or free surface. *c*. Capillaries, or deep surface. *g*. Follicle. *h*. Follicle dilated intò a sacculus. *i*. Follicle lengthened into a tubule, which is coiled up.—B. Multilocular crypts. *k*. Of tubular form. *l*. Saccular.—C. Racemose or vesicular compound glands. *m*. Entire gland, showing branched duct and lobular structure. *n*. A lobule detached, with *o*, branch of duct proceeding from it.—D. Compound tubular gland.

The principal object of a secreting glandular structure would seem to be a development or augmentation of surface sufficient to the purpose of elaborating the quantity of the specific fluid called for; in other words, for getting area for the requisite ends, like the display

of surface in the interior of the lungs for air enough by respiration. The glands seem, therefore, as said by some, to be a sort of efflorescence from the surface, or cavity upon which they discharge; being formed of canals with closed extremities, as originally asserted by Malpighi.

It is denied by Müller[1] that there are acini in any glands whatever (the testes of some few fishes excepted) existing, as commonly understood, to wit: as solid granules executing secretion, by means of their glomeruli of blood-vessels having ducts arising from them, in an unexplained way. On the contrary, he asserts that acini are merely bundles of fine tubes formed by the ends of secreting canals, or frequently by collections of the vesicular terminations of the latter. The term acinus, in its qualified sense, is sufficiently proper, but it should be remembered that in receiving it according to its meaning, which is a berry or grape, the skin of the grape and its pedicle are alone to be understood, the pulp being omitted.

In animals having blood, that fluid furnishes the constituents of the glandular secretions, sometimes without any change in them whatever, as in the case of water, common salt, and albumen; in other instances, products absolutely new are the result of glandular action, as in the case of urea, uric acid, and certain salts. Changes of organic form, as well as of chemical composition, are executed in certain glands, as, for example, the solid corpuscles existing in some secretions, and the seminal cells and spermatozoa produced in the testicle.

A regular circulatory apparatus, as a heart and blood-vessels, is merely accessory, and not essential to a glandular secretion. They, and the fluid they bear, appear to be introduced principally for the purpose of accelerating and of giving a higher energy to the actions of the parts they supply, which rule attaches not only to secretion, but to nutrition and all other functions. Where there is much motion of any kind there is much waste, and there must be correspondent supplies. Actions are much inferior in plants to what they are in the higher animals—the former can therefore dispense with heart and blood; their secretions are, however, not the less perfect, as seen in the production of young cells; spermatic filaments, essential oils, coloring matters, honey, starch granules, and various other matters.

As there is therefore only a qualified necessity for the presence of blood-vessels in glands, so their arrangement is modified accordingly. They are divided into the most extreme degree of minuteness, keep close together, and advance to within very short limits of the secreting surface, so as to make them appear almost a part of it. This expansion of surface, connected with a retarded flow of blood, favors, in the highest degree, the secretory action.

Though the blood-vessels have this intimate connection with secreting surfaces, the distinguished Müller[2] asserts that they are not to be considered as continuous with the cavities of the secreting tubes, but merely ramified on them by countless capillaries, the arteries simply terminating in the veins as in the case of the lungs, or, I may say, of the intestinal canal. This theory, however, is almost too exclusive;

[1] Physiol. p. 501. [2] Loc. cit.

there are most probably organized porosities in the capillary system, in the venous especially, forming a communication between the vessels and the canals on which they ramify. It is rather too easy to pass a minute injection from the capillary system into the canal upon which it ramifies, for us to suppose that every such case is one of rupture. We must, also, upon the ground of personal observation to the contrary, decline the opinion of Professor Müller, that there is no communication between the secretory ducts and the lymphatics.

The cause of the massive character of many glands and of their shape may now be understood. The shape of glands must depend measurably upon the space and circumstances in which they are accommodated; the diversity of shape in the three salivary glands shows that this is a point of merely local convenience, and is subordinate. Their size, however, is upon another ground: this is regulated by the amount of secretion to be done, and by the necessity of this secretion being collected at one or more points. The process of assimilation requires the bile in the duodenum, only, and that in large quantity; hence the liver is both a very large organ and all its secretion is concentrated in one focus. If the necessity for the latter had not existed, the liver, like the muciparous glands, might have been disposed in small granules all along the alimentary canal. This hypothesis, by the way, will show how the liver or any other gland may exist in the form of insulated acini without the function being altered; and also show the reverse, how if all the muciparous glands were collected into one mass for the purpose of having a focal point of discharge, that this arrangement would require also a single large duct made by the successive junction of branches, just as in the liver.

As the vascular capillaries ramify upon the parietes of the secretory tubes, so their parent branches are found in company with the larger branches of the latter. The development of the two systems is found to be simultaneous. The tubes are first of all planes, then simple canals or cœca, then primary branched canals or cœca, then undergoing an indefinite series of divisions. At first these canals are loose and unconnected, but as the evolution of the gland advances they cohere and become consolidated; but at every period of development and of perfection, the capillaries form a net-work around them smaller than the tubes themselves.

There is no essential correspondence between the construction of a gland and its secretion. Very different glands have similar structure, as the testes and the kidneys, and similar glands have a varied secretion in different animals. Even cells on the same surface are not restricted to the same action, for it has been asserted by Dr. H. Meckel that in the liver of mollusca he found some cells containing biliary matter and others containing fat. In the human liver itself the same may occur in a diseased state, and under all circumstances some will secrete mucus and others bile. The liver in one animal is simply in the form of cœca, in another of tufts of cœca; in others of branches of cells, or of a spongy tissue, or as a branched duct having terminal twigs like a feather. The testes are indefinitely varied; the kidneys alone maintain a constant character. The construction of a gland is always regulated by the special demand upon it by the condition of the animal in ques-

tion; hence the salivary glands are exceedingly simple in birds and serpents; the pancreas in fish; and the liver in the lower animals. Where more surface is required, then new processes from the main line of the secreting tube spring up.

Purkinjé remarked, that the walls of all secreting cavities or canals are formed by nucleated granules, of the diameter of $\frac{1}{33,000}$th of a line, elaborating or making, according to his phraseology, the glandular *Enchyma*, *product*, or *fluid*. With the aid of Schwann and Henle this arrangement has been found in all the glands and over the entire mucous surface, constituting in fact a cellular nucleated epithelium, which is now admitted to execute the specific secretion of all glands. This nucleated epithelium, formed of cells having a spheroidal or polyhedral outline, is spread as a close covering, and rests upon a simple membrane (*membrana propria*), or basement membrane as it is now generally called. This membrane limits the range of the blood-vessels, restraining them on one surface, while it fixes the secreting cells on the other. It has also the power of regenerating the cells because the latter are all deciduous and in a constant state of moulting as they become filled with their secretion; for the above cells having thus reached a state of maturity, and accomplished a perfect secretion within their own cavity so as to fill it, this secretion is discharged by their dehiscence, or dissolution, and is then conveyed to the point where it is wanted. The generation of secreting cells, thus exhausted, is succeeded by another generation, and so the process goes on during the life of the individual. It is thought that in some glands this succession is diffused over the whole free surface of the excretory tubes, but in others that it is confined to the extreme end or terminus.[1]

The determinate physiological doctrine of the day may be then summed up in the general declaration, that, whatever be the secretion in question, it is elaborated through the growth and nutrition of cells covering the free surface of excretory tubes and their branches, to their very end. So far as the microscope can avail, there appears to be no difference between the structure of the cells of one secretion and those of another. Their capacity to eliminate from the blood the specific secretion, is one of those abstruse acts of the system, depending upon an original endowment; a dictum, in other words, of that creative energy which spoke all things into existence, and still continues to retain them in it. In a case of this kind we may possibly rest contented with the wisdom of a former period. *Omnino autem cum Deus aliquid facit, nulla opus est ratione. Quomodo nos ex nihilo fecit?*"[2]

Biliary matter and oil are easily recognized in the above cells of the liver, by their difference of colour, and by their refracting powers: —milk is detected in a similar manner in the mammary gland; sebaceous matter also in the follicles of the skin, and so on of other glands.

Besides blood-vessels, nerves and lymphatics are found in glands; but other observations are required to understand the arrangement, this point in their anatomy being very defective.

[1] Goodsir; see Carpenter, Elem. Physiol. p. 409, Phila. 1846.

[2] St. Joannes Chrysostome.

There are some other organs called glands, but they differ from the preceding in having no excretory ducts. They are supposed to be limited in their function to the modifying, in some measure, the fluids going through them. One kind of them is formed essentially of blood-vessels, and they are called *Ganglia sanguineo-vasculosa;* of these we have the spleen for the chylopoietic system; the capsulæ renales for the kidneys; the thymus and thyroid gland for the organs of respiration, and the placenta for fœtal life. The second kind, called lymphatic glands (*Ganglia lymphatico-vasculosa*), consist essentially of lymphatic vessels entering on one side and departing at the other, after having divided into branches and cells in the thickness of the gland. There are also other glands whose character and functions are still more doubtful, they being found in contiguity with the encephalon, as the Pituitary gland, the Pineal, and the glands of Pacchioni.

The real glands, on the contrary, not only modify the blood which circulates through them, but give rise to a new fluid as a consequence of the transformation of the blood; and this new fluid is discharged for a specific purpose by its efferent tubes into contiguous canals or places.

CHAPTER II.

OF THE ABDOMEN GENERALLY.

THE cavity of the abdomen occupies the space between the inferior surface of the diaphragm and the outlet of the pelvis; a considerable part of it is, therefore, within the periphery of the lower ribs above, and of the pelvis below. It is completely separated from the cavity of the thorax by the diaphragm, with the exception of the foramina in the latter, for transmitting the aorta, the ascending cava, and the œsophagus. It is bounded below by the iliaci interni, the psoæ, and the levatores ani muscles; on the front and sides by the five pairs of muscles called abdominal; and behind by the lesser muscle of the diaphragm, the quadrati lumborum, the lumbar vertebræ, and the sacrum. The figure of this cavity is, therefore, too irregular to admit of a very rigid comparison with any of the common objects of life, but a little reflection, on the course of its parietes, will make it perfectly understood. It should be borne in mind, that the very great projection of the lumbar vertebræ forms for it a partial vertical septum behind, which, in thin subjects, is almost in contact with the linea alba in front, and may be easily distinguished through the parietes of the abdomen, when the intestines are empty.

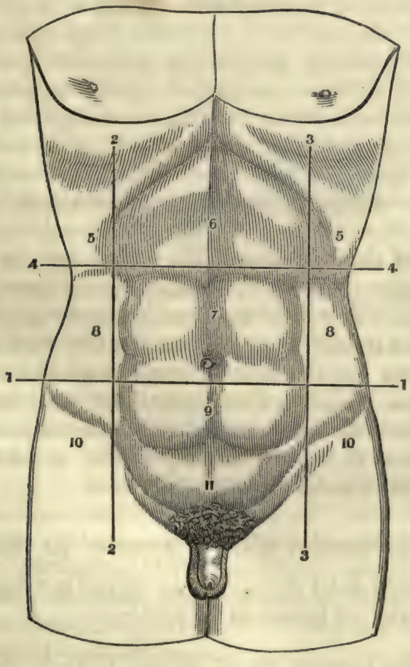
The abdominal cavity varies only inconsiderably in its vertical diameter, owing to the resistance of the diaphragm above, and of the pelvis below; neither does it change behind, owing to the resistance of the spine, the ribs, and the muscles there. But as the introduction of food, the development of gaseous substances during digestion, the evo-

lution of the fœtus, and many other conditions, require some provision for its undergoing an easy augmentation of volume; the latter occurs principally forwards and laterally, by the yielding of the muscles and by the extension of their aponeuroses.

The diaphragm and the abdominal muscles, for the most part, act alternately; as the former descends in inspiration, the latter relax and give way to the contents of the abdomen; but in expiration, the abdominal muscles contract, and the diaphragm is pushed upwards by the viscera. In attempts at the expulsion of fæces, and in parturition, these muscles contracting, and the diaphragm being fixed all at the same moment, the cavity of the abdomen is actually much diminished.

The viscera contained in the cavity of the abdomen are of three kinds. One kind is engaged in digestion and assimilation; another in the secretion and excretion of urine; and the third in generation. As these viscera are numerous, and it is of great importance to determine with precision their position and relative situation, anatomists are agreed to divide the cavity of the abdomen into several arbitrary regions. This

Fig. 156.



A view of the External Parietes of the Abdomen, with the position of the Lines drawn to mark off its Regions.—1, 1. A line drawn from the superior point of one ilium to the same point of the opposite one. 2, 2. A line drawn from the anterior inferior spinous process to the cartilages of the ribs. 3, 3. A similar one for the opposite side. 4, 4. A line drawn transversely to these, and touching the prominent margin of the costal cartilages. We thus form nine regions. 5, 5. The right and the left hypochondriac regions. 6. The epigastric region. 7. The umbilical region. 8, 8. The right and the left lumbar regions. 9. The hypogastric region. 10, 10. The right and the left iliac regions. 11. The lower part of the hypogastric, sometimes called pubic.

is the more advantageous, as the bony prominences bounding the abdomen are not sufficiently numerous and distinct, to afford those obvious

points of relation to the viscera which are furnished in other sections of the body. To obtain these regions, consider a line or plane as extending across the abdomen, about two inches below the umbilicus, from the superior part of the crista of one ilium, as it appears through the skin, to the corresponding place of the other side. Strike on each side a line perpendicular to the preceding, by commencing at the lower end of the anterior inferior spinous process of the ilium, carrying it up to the diaphragm. Extend a fourth line across the abdomen parallel with the first, and intersecting the last two where they come upon the cartilages of the false ribs. It is evident that these four lines or planes, two horizontal and two vertical, will, with the assistance of the parietes of the abdomen, furnish nine regions: three above; three in the middle; and three below. The central region, above, is the Epigastric; and on its sides are the right and the left Hypochondriac. The central region in the middle, surrounding the navel, is the Umbilical; and on its sides are the right and the left Lumbar. The central region below is the Hypogastric; and on its sides are the right and the left Iliac. There are also some subordinate divisions: for example, the hollow in the epigastric region, around the ensiform cartilage, is called the pit of the stomach, or Scrobiculus Cordis; and for an inch or two around the symphysis pubis, is the region of the pubes (*regio pubis*).

Anatomists differ among themselves about the points of departure and the position of the lines, or rather planes, separating the regions. Some fix them at definite distances from the umbilicus, and others resort to the points of the skeleton. The umbilicus is the most fallacious mark, because its elevation varies considerably, according to the state of distension of the abdomen, it being comparatively higher when the abdomen is tumid than when it is not. Neither does it answer to take the anterior ends of the last ribs as the points for the upper horizontal line to pass through; as they, sometimes, are almost as low down as the umbilicus itself. The superior anterior spinous processes are also objectionable as the points of departure for the vertical lines, as they leave too much room for the central regions of the abdomen, and too little for the lateral. I have, therefore, after some hesitation, thought it proper to substitute the anterior inferior spinous processes, and, especially, as the position of the viscera, according to almost universal description, is more in accordance with this rule.

General Situation of the Viscera of the Abdomen.

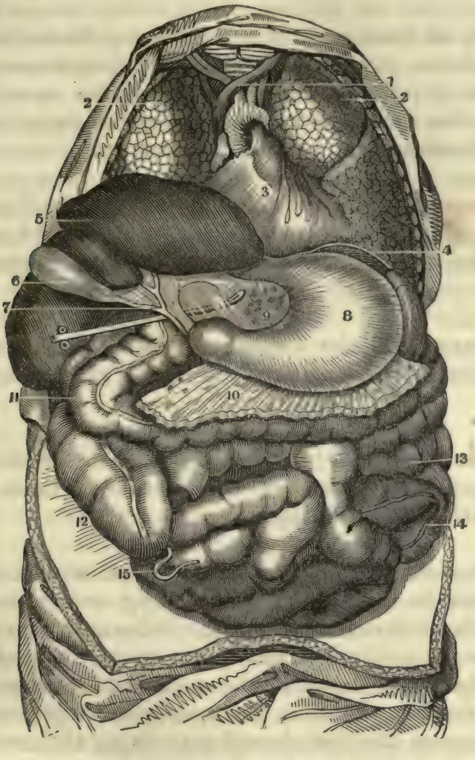
When the abdomen is so opened as to leave its viscera in their natural position, they will be found as follows:—

1. The Liver, the largest gland of the body, is in the right upper part of the abdomen, immediately below the diaphragm. It occupies nearly the whole of the right hypochondriac region; the upper half of the epigastric; and the right superior part of the left hypochondriac. The anterior extremity of the gall-bladder projects beyond its anterior margin.

2. The Spleen is situated in the posterior part of the left hypochondriac region.

3. The Stomach, in a moderate condition of distension, occupies the lower half of the epigastric region, and the right inferior portion of the left hypochondriac.

Fig. 157.



A view of the Abdominal and Thoracic Viscera.—1. The great blood-vessels of the heart. 2. The lungs of each side. 3. The heart. 4. The diaphragm. 5. Under surface of liver. 6. The gall-bladder. 7. Union of the cystic and hepatic ducts to form the ductus choledochus. 8. Anterior face of the stomach. 9. The gastro-hepatic, or lesser omentum. A female catheter has been passed through the foramen of Winslow, and is seen through the omentum. 10. Gastro-colic, or greater omentum, cut off, so as to show the small intestines. 11. The transverse colon, pushed slightly downwards. 12. Its ascending portion, also pushed down. 13. Small intestines. 14. The sigmoid flexure. 15. Appendicula vermiformis.

4. The Small Intestine, when moderately distended by flatus, occupies the umbilical region, the hypogastric, portions of the iliac on each side, and also the upper part of the cavity of the pelvis, when the viscera of the latter are empty.

5. The Large Intestine traverses the cavity of the abdomen in such a manner as to perform almost the entire circuit of it. It begins in the right iliac region by receiving the lower extremity of the small intestine; it then ascends through the right lumbar and the right hypochondriac, passes into the lower part of the epigastric, or into the upper of the umbilical, according to the state of distension of the stomach; thence it gets into the left hypochondriac, being fixed higher up there

than in the corresponding region of the other side; afterwards it goes down into the left lumbar and into the left iliac, where it makes a large long loop, called its sigmoid flexure; thence it passes into the pelvis, in front of the left sacro-iliac junction, and inclining afterwards to the central point of the sacrum, it subsequently descends in front of the sacrum and coccyx to terminate in the orifice called anus.

6. The Caul, or Omentum, is a membrane, of various densities, in different individuals, and lies in front of the intestines. Sometimes it is found spread over the latter like an apron, but on other occasions is drawn up into the umbilical region, forming a ridge across it. It is attached to the stomach and large intestine.

7. The Pancreas lies transversely in the lower back part of the epigastric region. It extends from the left hypochondriac region to the right side of the spine, and is placed behind the stomach, so as to be covered by it.

8. The Kidneys and the Capsulæ Renales, each two in number, are placed in the posterior part of the lumbar region on the side of the spine.

9. The Urinary Bladder and the Rectum, in the male, occupy the cavity of the pelvis; and in the female between them are placed the uterus, the ovaries, and the vagina.

As, in the dissection of the abdominal viscera, the subject is commonly placed on its back, so the preceding description is made out with a strict reference to that position. Some modification in the shape of the abdomen, as well as in the situation of its contents, occurs in standing upright. The front of the abdomen becomes then more protuberant, the lumbar vertebræ make a greater projection forwards. The pelvis is also so adjusted, in order to bring the acetabula directly in the line of support to the spine, that the convexity of the sacrum presents almost upwards, and the superior strait looks forwards and upwards towards the navel, so that much of the weight of the viscera is thrown upon the pubes. In this attitude most of the viscera descend, but more obviously the liver, from its weight, size, and solidity. Portal has verified this descent by comparing the thrusts of poniards into the liver in the erect, with those inflicted in the horizontal, position. He also asserts that the same may be ascertained in the living body by applying the fingers under the false ribs, and then directing the person to change from the recumbent into the vertical position. The spleen affords the same results when it is slightly enlarged, and the descent of the liver and spleen will of course insure that of the stomach and intestines. According to Winslow, the pain and faintness which are felt after a long abstinence, come from the vacuity of the stomach and intestines, which thereby withdraw their support from the liver, and permit it to drag upon the diaphragm.

The presence of flatus in the stomach and intestinal canal seems to be entirely natural to them; for it is comparatively rare to find them

destitute of it, even when they contain no food or fæces. The large intestine is, however, more frequently found contracted or empty than the small. Owing to the flexible character of a considerable portion of the abdominal parietes, the latter, by their own contraction, as well as by atmospheric pressure, are kept in close contact with the viscera; and the viscera again, by the same influence, are kept in close contact with one another; so that, notwithstanding the irregularity of their forms and the fluctuating size of the hollow ones, there is no unoccupied space in the cavity of the belly.

Several instances are reported by anatomists, in which a total transposition of the abdominal viscera has occurred, so that those which belonged to the right side were placed in the left.[1] They are, however, exceedingly rare. In the entire observation of my life, amounting to forty years of anatomical study, and extending itself to many hundred bodies, I have not met with one instance of it.

CHAPTER III.

OF THE PERITONEUM, AND SEROUS MEMBRANES, GENERALLY.

SECT. I.—OF THE PERITONEUM.

THE sides of the abdomen are lined, and its viscera are covered by a membrane, the Peritoneum; the first may be called the *parietal*, and the second the *reflected* portion. As the reflections of this membrane, by being thrown over the periphery of almost every viscus of the abdomen, consequently, assume the same shape; and as it lines, without exception, the interior surface of every part of the abdomen, its form is extremely complicated, and can only be judged of accurately after the study of the viscera is completed. For the present, it will only be necessary to give the outline of it, leaving the details to each appropriate occasion.

In man, it is a complete sac, having no hole in it; but in woman, its cavity communicates externally through the Fallopian tubes. It has a double use: in consequence of covering the viscera, it is so reflected from them to the sides of the abdomen, that its processes keep the viscera in their proper places, and therefore answer as ligaments; again, its internal surface being smooth, indeed highly polished, and continually lubricated by a thin, albuminous fluid, corresponding with the synovial membrane of the joints, the motions which the viscera have upon each other in exercise, and in the peristaltic action of the bowels, are much facilitated.

The manner in which a double night-cap is applied to the head will afford the easiest conception of the reflections of the peritoneum. If there were only one viscus in the belly, and that of a somewhat regular

[1] Portal, Haller, Sandifort, &c.

outline, as the spleen, the comparison would be rigid, and perfectly appreciable. One part of the cap is close to the head, and compares with the peritoneal coat of the spleen; the other is loose, and is equivalent to the peritoneum, where it is in contact with the parietes of the belly. It is also evident from this that none of the viscera can be said to be within the cavity of the peritoneum; that they are all on its outside; and that a viscus, in getting a coat from the peritoneum, merely makes a protrusion into its cavity. Starting with this simple proposition, it is easy to conceive of a second, a third body and so on, deriving an external coat from a protrusion into the same sac. Admitting these bodies to be spheres, the proposition is immediately intelligible; and, as a last step from it, the idea is not rendered much more complex by substituting any bodies, even the most irregular in form, for these spheres.

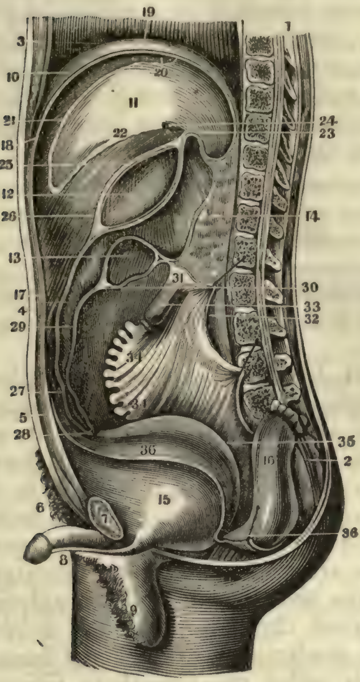
Such, then, is the fact in regard to the stomach, intestines, &c.; they all, with the exceptions to be stated, derive an external coat from the peritoneum.

The Peritoneum is, for the most part, smoothly spread upon the interior surface of the abdominal muscles. It adheres to them with considerable firmness by means of intervening cellular substance; this adhesion, where it closes the posterior opening of the umbilicus, is unusually strong. Below, the uniformity of the membrane as it descends from the navel to the pelvis is interrupted by its being reflected over the urachus, and over the remains of the umbilical artery on each side. Where the urachus is, it forms an oblong prominent ridge, reaching to the upper extremity of the bladder; and as regards each umbilical artery, the duplicature is of a variable breadth in different individuals; but always forms a well marked falciform process, reaching from near the umbilicus to the lower side of the bladder, and dividing the inguinal region into two parts or fossæ, one next to the pubes, and the other near to the ilium. In the undistended state of the bladder the peritoneum reaches to the pubes, is reflected from the latter to the upper, and then goes over the posterior surface of the bladder. In the male, it goes from the posterior lower end of the bladder to the rectum; but in the female it does not descend so low there, and passes from the bladder to the vagina and uterus, and afterwards to the rectum.

In the concavity of the ilium, and in the lumbar region, the peritoneum is attached by long loose cellular substance, which permits it to be stripped off easily, simply by tearing. In these several regions it encounters the colon, over which it is reflected, and thereby forms the Mesocolon; thence it passes in front of the kidneys, but separated from them by a thick layer of cellular and adipose matter, and immediately afterwards it is thrown into a long duplicature, extending obliquely across the lumbar vertebræ from above, downwards, and to the right side. This duplicature includes the small intestine, and is the Mesentery.

In the highest regions of the abdomen, the peritoneum is in the greater part of its extent uniformly reflected over the concave surface of the diaphragm, and adheres so closely to it, as to require a cautious and protracted dissection for its entire removal. As the remains of the umbilical vein of the fœtus are still found but in a ligamentous

Fig. 158.



A Plan of the Reflexions of the Peritoneum, as given by a Vertical Section of the Body of a Man. —1. Spinal column, and canal. 2. Sacrum. 3. Sternum, &c. 4. The umbilicus. 5. A section of the linea alba. 6. The mons veneris. 7. Symphysis pubis. 8. The penis divided at the corpora cavernosa. 9. Scrotum. 10. The superior right half of the diaphragm. 11. A section of the liver. 12. A section of the stomach, showing its cavity. 13. A section of the transverse colon. 14. Cavity of peritoneum behind the stomach. 15. A section of the bladder, deprived of the peritoneum. 16. The rectum, cut off, tied, and turned back on the promontory of the sacrum. 17. The peritoneum covering the anterior parietes of the abdomen. 18. The peritoneum on the inferior surface of the diaphragm. 19. Convex side of the diaphragm. 20. Reflexion of peritoneum from diaphragm to liver. 21. Peritoneum on front of liver. 22. The same, on its under surface. 23. The hepatico-gastric or lesser omentum. 24. A large pin passed through the foramen of Winslow into the cavity behind the lesser omentum. 25. The anterior layer of the hepatico-gastric omentum, passing in front of the stomach so as to make its peritoneal coat there. 26. The same membrane leaving the stomach to make the anterior of the four layers of the great omentum. 27, 28. The peritoneum from the front and back part of the stomach, as they turn to go up to the colon. 29. The front and back of gastro-colic, or greater omentum. 30. The separation of its layers, so as to cover the colon. 31. The posterior layer passing over the duodenum. 32. The peritoneum in front of the right kidney. 33. The jejunum cut through and tied. 34, 34. The mesentery cut off from the small intestines. 35. The peritoneum reflected from the posterior parietes of the bladder to the anterior of the rectum. 36. Its cul-de-sac between the bladder and rectum.

condition, going from the navel to the under surface of the liver, their existence gives rise to the falciform ligament, a broad duplicature of peritoneum, which passes from the upper half of the linea alba and from the middle line of the diaphragm to the liver. Another line of attachment, or of reflection, of this membrane to the liver is found all along the posterior margin of the latter. In the same region, it is also reflected from the diaphragm to the spleen and to the stomach. Such is the general account of the course of the peritoneum. Each of the duplications has a distinct name, and some peculiarity of organization or of relation, which will require a specific description and a frequent allusion to it.

It is proved, from what has been said, that the peritoneum is a

single and complete sac, and that, with the exception stated of the Fallopian tubes, there is no hole in it either for the passing of blood-vessels, nerves, or viscera; and that it is so folded over the abdominal viscera, that, with patience and sufficient address, one might remove it from their surface and extract them, without even laying open its cavity: an experiment said to have been successfully accomplished by Nicholas Massa,[1] and some other anatomists.

SECT. II.—OF THE OMENTA.

There are four processes of the peritoneum each of which is designated under the term Omentum, Epiploon, or Caul.

1. The Omentum Minus, or Hepatico-Gastricum, extends, as its name imports, between the liver and the stomach. It begins at the transverse fissure of the liver, proceeds from it, and from the lobulus Spigelii, the front of which it conceals, and then continues to arise along the left margin of the base of this lobule to the back part of the liver until it reaches the diaphragm. It also arises from the inferior surface of the tendinous centre of the diaphragm along its posterior lower border, and is attached to the lesser curvature of the stomach in all the space between the cardiac and the pyloric orifice. Its right margin reaches beyond the pylorus to the duodenum, and includes the vessels going to the liver, and the biliary ducts; in consequence of which, this margin is called the Capsule of Glisson. The capsule is, however, more properly the condensed cellular substance within.

The two laminæ which compose the omentum minus are thin, transparent, and have but little fat in them; in approaching the stomach they become very distinct from each other, and receive between them the superior coronary vessels of the stomach. One lamina then goes before the stomach and the other behind, in the form of a peritoneal covering. These laminæ, having covered in that way the anterior and the posterior surface of the stomach, unite again on the greater curvature of the latter, to form the beginning of the omentum majus.

2. The Omentum Majus, or Gastro-Colicum, as indicated by its name, is connected at one end all along the greater curvature of the stomach, and by the other along the transverse part of the colon. As it commences by two laminæ, so it is continued throughout in the same way. It is commonly found more or less spread on the front surface of the small intestines, but occasionally it is tucked up in the epigastric region. When fairly spread out, either naturally or artificially, its course will be found as follows. It first of all descends from the stomach to the pelvis; it then turns upwards, so as to reverse its course, and continues to ascend till it reaches the colon. Its two laminæ then separate and receive the colon between them, so that, in this respect, the arrangement is entirely conformable to what happens to the stomach. The

[1] Anat. Liber Introduct. an. 1539. Portal.

subsequent continuation of these laminæ is the mesocolon, which will be more particularly described.

As the omentum majus consists of two laminæ in its whole extent, it is clear that it resembles a flattened bag lined by another bag; so that in its whole thickness, when held between the fingers, there are four laminæ. It is an irregular quadrilateral membrane, which, in corpulent subjects, is interspersed with a great deal of fat; but in such as are emaciated it is wholly destitute of the latter, and instead of being entire in its parietes is a delicate reticulated membrane, so that the rule about the integrity of the peritoneum is not fully accurate as applied to this section of it. On the right side it is continuous with the omentum colicum, and on the left with the omentum gastro-splenicum.

3. The Omentum Colicum may be considered as a continuation of the omentum majus along the ascending and a part of the transverse colon. In some rare cases, (for in my own observations I have not met with the arrangement,) its origin is continued downwards to the cœcum, and at its left margin is extended along the transverse colon to the spleen. Much more commonly it is, as stated, simply an appendage of the great omentum, or its right flank, advancing for a short distance along the ascending colon.

It consists of but two laminæ in all, commonly containing fat, but in this respect is subject to the same rule as the omentum majus.

4. The Omentum Gastro-Splenicum is the left flank or margin of the omentum majus, extended from the great end of the stomach to the spleen. It of course consists of but two laminæ, which contain between them the splenic vessels and the vasa brevia.

By looking for the posterior end of the gall-bladder, and then passing a finger under the right margin of the hepatico-gastric omentum, or in other words, under the capsule of Glisson, where it extends from the liver to the duodenum, the finger will be found to have insinuated itself behind the stomach, and, by being directed downwards, will be thrust into the sac or cavity of the great omentum. In children, where the latter is less reticulated than in adults, and consequently more entire, a large blowpipe introduced at the same point will enable one to inflate this cavity, and to separate its anterior from its posterior wall. This aperture, called the foramen of Winslow, is the route by which the internal or lining lamina of the omentum majus is introduced, so as to make this process of peritoneum double throughout its whole parietes. Though this fact of duplicity is generally conceded, no author heretofore, to my knowledge, has pointed out satisfactorily the means; and for the suggestion of it, I am indebted to a learned and zealous member of the profession, now Professor Hodge of the University. Struck, at an early period of his studies, with the difficulty of tracing a double sac to the omentum majus, out of a single membrane of the peritoneum, this suggestion was happily made by him to remove the difficulties of other explanations. An attempt at a diagram formed upon any other principle I have invariably seen to fail. If the reader has conceived the idea, the inference will be plain, that the lining lamina of the omen-

tum majus is continued as a common peritoneal covering over the posterior face of the stomach, and then forms the posterior lamina of the hepatico-gastric omentum. It will also be plain that the same lamina, having reached the colon in its return, continues afterwards as the upper lamina of the transverse mesocolon.

From what has been said concerning the general qualities of the peritoneum, it is to be understood that though it enjoys much power of gradual extension, nevertheless this quality is not sufficient to enable it to endure, without a special provision, the sudden and extensive dilatations to which the stomach and bowels are exposed, from the introduction of food and from the evolution of gases during digestion. Of all the coats of these organs, it is the least extensible and contractile; its rupture, therefore, is guarded against by one invariable rule. For example, as the muscular and other coats of the stomach dilate, the peritoneum is drawn from the omentum minus and majus to cover the stomach; therefore, as the stomach enlarges, the omenta diminish, and as the stomach decreases, the omenta, by the restoration of peritoneum, resume their primitive size. In this way the uterus, notwithstanding its great augmentation in the progress of pregnancy, still keeps itself covered by peritoneum, from the ability of the latter, as mentioned, to slide from one part and to apply itself to another. The true intention, then, of the apparently useless length of many processes of the peritoneum is explained, by their being a provision for the augmentation of the hollow viscera of the abdomen, in the discharge of their natural functions. Adopting this explanation as the basis of our observations, we shall find that according to the probable or even possible augmentation of a viscus, so are its peritoneal attachments. The stomach, which next to the uterus enlarges more than any other viscus, gets its subsidiary supply of peritoneum from the length of the omentum minus and majus; the colon, which is next in order, is supplied from the length of its mesocolon; the small intestines, which are next, from the length of the mesentery. The latter, however, would be too long for that simple purpose; but the objection is removed by recollecting that the mesentery has also to accommodate numerous chains of lacteal glands, through which the chyle must pass in its elaboration, before it is fit to enter into the general circulation. The liver, being of a size almost stationary, has its peritoneal attachments proportionally short; and its peritoneal covering, from the shortness of the connecting cellular substance, is disqualified from sliding. The spleen is in the same predicament with the liver, except that its size is not stationary; but in this case, the peritoneum presents a phenomenon entirely remarkable; it wrinkles upon the contraction of the spleen.

If this mode of reasoning, derived from an arrangement of parts which no one denies, be correct, it follows that physiologists have erred sadly in the supposed uses of the omentum majus. That this organ is, in fact, only subsidiary to the enlargement of the stomach and colon, so as to prevent the rupture of their peritoneal coat, and that it is neither intended to keep the belly warm, as so learned a naturalist as M. G. Cuvier has suggested,[1] nor is it a special store-house for the

[1] XXII. Leçon D'Anat. Comp.

wants of the system during the destitution of other aliment, farther than adipose matter in other parts of the body is.[1] In regard to the first theory, it does not appear that the inhabitants of cold climates are better furnished with an omentum majus than those of the torrid zone; that it is better developed in winter than it is in summer; that it is tucked up in warm weather to cool the intestines, or spread out in cold weather to make them more comfortable. On the contrary, it is ascertained that its position is variable at all seasons; that in the coldest of weather it is as often found collected in the epigastric region, or to one side of the abdomen, as it is in the warmest; consequently, its position is the result of whatever motions may, for the time, have been impressed upon it by the distension of the stomach, and by the peristaltic movements of the bowels. In regard to the theory of Dr. Rush, this objection is insurmountable; that children, who are equally, if not more exposed to starvation and sickness than adults, never have fat, except in very small quantities, in the omentum, and that only along the course of its vessels. The fat is, therefore, not to be viewed as an essential circumstance in the structure of the omentum, as all children and many adults have it only very sparingly; for the omentum being wanted as a membrane of reserve to the stomach and colon, the deposit of fat in it is in obedience to one of the general laws of the system, whereby the cellular substance beneath the serous membranes is disposed to secrete fat as the individual advances in life; which is exemplified on the heart and in the pleura. Another argument is that, in the ruminating animals, where there are four stomachs, and from the vegetable nature of their aliment these stomachs must, in the course of digestion, be very much distended, the great omentum is of proportionate magnitude.[2]

As occurs in other parts of the body, also, the fat of the omentum accumulates in animals that take but little exercise, while it is very deficient in such as lead an active life.

There is reason to believe that the hard knots felt in the abdomen of such persons as suffer from abdominal affections, frequently depend upon the accumulations of the omentum majus at particular but variable points.

SECT. III.—HISTOLOGY OF THE SEROUS MEMBRANES.

As the peritoneum presents one of the best examples of a numerous class of membranes, called Serous, it will be useful at this point to inquire into their general condition and properties. They are, for the most part, thin, and strongly resemble compressed cellular membrane.

They assume the form of perfect sacs, and as they are found in all parts of the body, they are kept distinct from each other. The arachnoid membrane of the brain, the pericardium, the pleura, the synovial membranes of the joints, the bursæ mucosæ of tendons, the peritoneum, and the tunica vaginalis testis, belong to this class. They are not all

[1] An Inquiry into the Uses of the Omentum, by James Rush, Philad. 1809.

[2] Cuvier, XXII. Leçon, loc. cit.

of the same thickness, as some are much more dense than others; they adhere to neighboring parts by a lamina of cellular substance, which is also of variable thickness and ductility; indeed, on some occasions, it is not entirely distinct, from its extreme shortness and tenuity.

As the serous membranes are only displayed over the surface of the organs which they cover, after the manner of a double night-cap drawn over the head, their cavity always remains entire, notwithstanding it is variously modified by the shape of the organs protruded into it, and has its parietes in contact, owing to external compression. They are entirely distinct from the essential structure of the organs covered, and are displayed over those of the most dissimilar functions, as, for example, the intestines and the liver. A sac of this description, then, is of infinite importance in establishing between organs which border upon one another a strong partition, and, consequently, in warding off any injurious influence which their dissimilar natures would otherwise cause them to have upon each other. Important organs are, therefore, invariably thus insulated, so that whether in a healthy or in a diseased state, their actions are carried on within themselves; and not only so, but it is even possible, and, indeed, is found in morbid dissections, every day, that an organ may be diseased while its serous covering is unaffected, or the reverse. Thus, we have large suppurations in the liver, while its peritoneal coat is healthy; large accumulations of water in the tunica vaginalis testis, while the testicle itself is sound; in the thorax, with sound lungs and heart; in the abdomen, with viscera generally sound; in the joints, without an affection of the bones. Nothing is more common than to see partial adhesions, the result of inflammation, causing the opposite sides of these sacs to adhere, without any evident constitutional or visceral derangement; and some of our plans of cure, as in the hydrocele, are founded upon this well-established fact.

The serous membranes are throughout thin, transparent, and white: in some points their tenuity is so extreme that they seem to consist simply in a smooth, polished surface, spread over parts; this is strikingly the case on the interior face of the dura mater, on the ventricles of the brain, and on the cartilages of the joints. The evidence of their extension there is much assisted by morbid alterations, in which they become thickened. Their internal surface in a natural state is always smooth, highly polished, shining; and, being also lubricated by its peculiar unctuous secretion, the opposite parietes, when they come into contact, glide freely upon each other; a circumstance indispensable to the free action of the joints, and to the peristaltic motion of the bowels. Bordeu has asserted, that these remarkable characters of the serous membranes depend upon the compression and the friction to which they are continually exposed; but to this opinion the argument of Bichat is unanswerable, that in their earliest observable period in the fœtus they have the same polish.

The fluid secreted from the serous membranes resembles, strongly, the serosity of the blood. It is poured out continually by the exhalant orifices, and, in a short time afterwards, is taken up by the absorbents; so that in a natural state there is seldom more than sufficient to lubri-

cate the surface of the membrane. When the abdomen of an animal, recently killed, is exposed to the air, this fluid rises in the form of a vapor. The several experiments, as the application of heat, mineral acids, and so on, which prove the abundance of albumen in the serum of the blood, produce the same results when applied to the secretion from the serous membranes.

The system of serous membranes has been considered by Bichat and others as only a modification of cellular membrane, for the following reasons: The inflation of air into the cellular tissue subjacent to them, reduces them to the form of cellular substance. Protracted maceration produces the same effects with more certainty and precision. When cellular membrane is inflated, the parietes of the distended cells resemble strongly the finest parts of the serous system, as the arachnoid membrane. There is an identity of functions and of affections, for they are both continually engaged in the great work of exhalation and absorption, and suffer in the same way from dropsical effusion, with the only difference that the latter is more amassed in the one than in the other. Dropsy very seldom manifests itself, to any extent, in the cellular tissue without also going to the serous cavities, and the reverse.

Serous membranes, though when examined by the naked eye have the appearance of a texture perfectly uniform and destitute of fibres, are yet by the microscope ascertained to be filamentous at their base; to have upon this what is called by Messrs. Todd and Bowman a basement membrane, and upon this again a covering of epithelial cells.

The fibrous or filamentous layer is that which resembles so closely compressed cellular substance, and, like it, consists of bundles of white filaments: these bundles decussate one another when they are in more than one layer, and are mixed to some extent with yellow elastic tissue which, as usual, has its filaments reticulated. According to Henlé, in some of the serous membranes this elastic tissue exists principally as a layer just below the basement membrane.

Basement membrane.—By acting on the inner surface of a bivalve shell with dilute acid, a very thin pellicle is raised of a structure so uniform and so destitute of organic arrangement that it resembles more the walls of a soap bubble, and is hence defined as being amorphous or structureless. In some parts of the human body the same exists; in others it is modified by being granular, and in others again by being covered with epithelial scales. This membrane, wherever found, has been designated by Messrs. Todd and Bowman as a basement or primary membrane, and is supposed by them to be the matrix of the epithelial scales, which are successively evolved from its free surface, if it does not itself undergo a constant disintegration and renewal. All serous cavities are considered to be lined by such basement membrane in some of the conditions indicated.

Epithelium.—By scraping with the edge of a knife the fine surface of a serous membrane, a soft material can be detached, which, upon examination, will be found to consist of this epithelium, the parts of which cohere like mosaic work, and may be rendered more manifest by the use of some weak acetic acid.

The microscope has thus proved that notwithstanding the extremely polished surface of the free side of the serous membranes, yet they are

covered by an epithelium, which epithelium has been found on all except the subcutaneous bursæ. Reichert indeed has described an epithelium upon the interior surface of the tendinous and of the subcutaneous bursæ, like that of the arteries and of the true serous membranes.[1] The epithelium of the serous cavities is, like the epidermis, formed of flattened scale-like cells, which are, for the most part, polygonal or tesselated, like a pavement made of hexagonal bricks, and have each a nucleus in their centre. Some of these cells are furnished at their edges with minute hair-like filaments called cilia, which, during life and for some time after death, are in a state of continual whirling or vibration, and, as is supposed, for the purpose of preventing a stagnation of the fluids in contact with them. These cilia are especially numerous and active in the ventricles of the brain. In some places the epithelium is found without the serous membrane beneath; hence it is inferred that the latter is not so essential as the former in the character of such membranes.

These epithelia being always in contact with fluids, they differ from the cuticle by being pliant and humid; but are restored with equal facility when they are lost by abrasion or inflammation.

The Serous membranes are furnished with a great abundance of exhalant pores, and of absorbents, which carry on their functions with great activity. They, when healthy, receive only the colorless part of the blood, whence the uniform transparency of these membranes. The existence of exhalant pores is proved by strangulating a piece of intestine with a ligature for thirty-six or forty-eight hours, when they become evident, by dilating themselves so as to receive red blood. A fine colored injection produces the same result; and also moistens, by the escape of its watery particles, the surface of the intestine, by a very fine halitus or dew. The intestine of a living animal, if wiped perfectly dry, will, after the same way, soon present another coat of serosity on its surface. The existence of absorbents to a great extent in them may also be equally well proved, as they very readily receive a mercurial injection, which diffuses itself over their whole surface, and causes them to have the appearance of being formed entirely of such vessels. The readiness with which fluid effused into their cavities is taken up, is another proof of the same. Bichat once saw them distended with air in a man who had become emphysematous from poisoning. Mascagni has frequently found them distended with the fluid of dropsical collections, which he recognized by its color. It happened to the same anatomist to find in two bodies, where there had been an effusion of blood into the thorax, the absorbents of the lungs gorged with blood. This faculty of absorption may sometimes be proved to continue for some hours after death, by keeping an animal in a warm bath. Mascagni asserts, that he has witnessed its continuance for fifteen, thirty, and even for forty-eight hours; it is not improbable, however, that there was some illusion in these instances.

In a preparation made by myself of the peritoneal coat of the stomach, pores giving this membrane a cribriform condition are very visible; and Dr. Leidy, to whom I am indebted for a drawing of the same, has the

[1] Müller. Arch. 1844.

facility of detecting, by the naked eye, similar pores over the whole peritoneum. Whether these pores are exhalant or absorbent, I have not yet ascertained.[1] They, by their uniformity and smoothness, bear every indication of being organized pores. If a similar arrangement exist everywhere over the entire extent of serous membranes, it is not an unreasonable conjecture to consider them as absorbing orifices, and thus to explain the high absorbent powers of such membranes. These orifices are most probably formed by meshes of lymphatics; as upon the mucous surface of the gastro-intestinal mucous membrane, the Follicles of Lieberkühn, or the gastro-enteric follicles, are formed by meshes of veins. As serous membranes are also furnished with their epithelium, hence, when it is raised by insufflation, the air does not escape through these pores.

It is more than probable that the serous membranes are internally deprived of red blood-vessels; the latter unquestionably exist, in great numbers, on the exterior surface, where they creep through the cellular substance, but they may be removed with a scalpel without affecting the continuity of these membranes. Again, where these membranes are free and unconnected on both surfaces, as in some parts of the tunica arachnoidea, there is no appearance of red blood-vessels. In hernial protrusions, where there is a considerable prolapse of peritoneum, the blood-vessels which are found abundantly about the neck of the sac do not follow out the course of the protrusion. Unquestionably some communication exists between the arterial system and the serous membranes, as proved by exhalation and morbid phenomena, but the mode is not well ascertained. We learn, however, upon the authority of Müller,[2] that there are some preparations of the peritoneum by Bleuland at Utrecht—and some also by Der Kolk, of the same membrane—which prove indubitably that this membrane contains vessels.

In common hernia and in dropsy, the serous membranes become more thick: from my dissections I am inclined to think that this change is not so great as is generally allowed; for most frequently, by a careful removal of the exterior cellular substance, they have been restored to their primitive condition. In other cases, as in large umbilical herniæ, they are so much attenuated as to be found with difficulty.

The power of extension which these membranes possess is strikingly marked in dropsical effusions, in the development of tumors, and in pregnancy; but much of this apparent quality is derived from their mode of attachment to adjacent parts, whereby they are drawn from one surface to cover another. This happens daily where the peritoneum is drawn from the lower part of the abdomen to cover the bladder in the distensions of the latter; in pregnancy, where it is drawn upon the growing uterus from all the neighboring parts; and in the distensions of the stomach by food or flatus, where it is drawn up from the omenta. The serous membranes have also a power of contraction equal to that of their extension; but it should not be confounded with that condition where they are simply restored by the connecting cellular substance to the surfaces to which they originally belonged.

The sensibility of the serous membranes is extremely obscure in a

[1] See plate, article Stomach.

[2] Physiol. p. 226.

natural state, and only affords an imperfect sensation of touch. This is proved by the impunity with which they may be irritated on living animals. This has generally been attributed to the want of nerves, which, however, have been lately traced into the pia mater and arachnoid by Purkinjé and Rainy—and into the peritoneum and pleura by Bougery. But, when the condition of inflammation is once established, they feel the most acute and distressing pain. Though they resist most frequently, and for a long time, disease in adjacent parts, yet it not unfrequently is extended to them at last. In such cases, it is generally a local instead of a universal affection, which is communicated to them; thus, in the cancer and scirrhus of the uterus, in disease of the spleen, &c., the portion of the peritoneum nearest the affected organ manifests the marks of the disease by preternatural adhesions and by disorganization, without the whole membrane being involved.

As the serous system consists in many species of sacs, so each of them has some peculiarity of organization, of attachment, and of vital properties, which is stated elsewhere in the account of the species themselves.

CHAPTER IV.

OF THE CHYLOPOIETIC VISCERA.

SECT. I.—OF THE STOMACH.

The Stomach (*ventriculus, stomachus*) is a hollow viscus situated in the epigastric region, intended to receive at one end alimentary matters from the œsophagus, and to transmit them, at its other extremity, after digestion, into the intestinal tube, where the nutritious part of the food is absorbed into the circulation. It is a conoidal sac, curved consider-

Fig. 159.

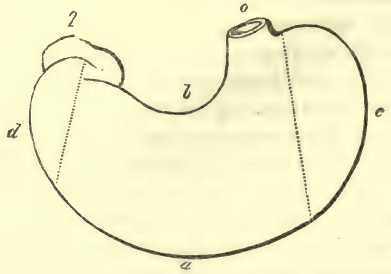


Diagram Outline of Stomach.—*a*. Great curvature. *b*. Lesser curvature. *c*. Left end, great cul-de-sac or fundus. *d*. Right end and small cul-de-sac. *o*. Œsophageal orifice or cardia. *q*. Duodenal orifice or pylorus.

ably upwards, and presents two Faces, two Orifices, two Curvatures, and two Extremities.

The Faces of the stomach are, from their position, named anterior and posterior, or one presents to the linea alba and the other towards the spine. The flat configuration is rendered more obvious when the organ is empty; for when distended it is rounded, and the anterior face is caused to look forwards and upwards from the resistance of the spine behind, while the posterior is of course in an opposite direction. In other respects they do not present anything worthy of particular attention.[1]

The two Orifices of the stomach are named Cardia and Pylorus. The first or Cardia is at the left and most superior part, but removed to the distance of two inches or more from the left extremity. It is generally considered a smooth, uninterrupted continuation of the œsophagus into the stomach, immediately after the œsophagus has passed through the diaphragm into the abdomen. But in a preparation of this organ made by drying,[2] and now in the anatomical cabinet, a circular rounded pad is very perceptible at the cardiac orifice; being elevated two lines or more all around, so that it makes a perfect ring of from eight to twelve lines broad at its base. This pad seems to be composed of a cellular substance, which is almost perfectly white, elastic, and consists of the finest filaments, resembling carded cotton; it is placed between the lining membrane of the cardiac orifice and the adjoining coat.

The Pylorus, when viewed externally, looks like a smooth continuation of the stomach into the duodenum; but when felt, there is a manifest thickening of the part, depending upon a structure to be presently explained. It points upwards, and, when the stomach is much distended, this orifice looks somewhat to the left side. It is, by the whole thickness of the liver, lower down than the cardia.

The two Curvatures are designated the great and small, or the upper and the lower. The first, forming the upper margin of the stomach, is bounded at its extremities by the orifices, and is very concave; its curvature is maintained both by a natural configuration and by the small omentum. The great curvature forms the whole inferior periphery of the organ, extending also from one orifice to the other. When the stomach is flattened, these curvatures form very evident boundaries to the anterior and to the posterior face.

The Extremities of this organ are remarkably different in size. That to the left forms the base of the cone, or the large extremity, and projects considerably beyond the cardia towards the spleen. It is a rounded pouch or cul-de-sac, like a tuberosity, the dimensions of which will, of course, vary according to the state of distension. The right extremity, on the contrary, is produced by a gradual diminution of the organ from its middle to the duodenum. When the stomach has approached within an inch or two of the latter, it suffers a sort of constriction, which gives to the right end a more cylindrical shape. This part is sometimes called the small cul-de-sac, or the Antrum pylori.

When the stomach has been kept empty for some time previous to death, it is found not much larger than an intestine; its variable mag-

[1] In some cases the posterior face of the stomach is concave to accommodate it to the spine; this is best seen on inflation and drying.

[2] December, 1828.

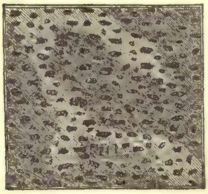
nitude, therefore, prevents any very rigid rule of dimensions from being applied to it; most commonly, however, we find it between the capaciousness of a pint and of a quart measure.

It is retained in its situation by its continuity with the œsophagus and duodenum; also by the hepatico-gastric, and the gastro-splenic omentum. It is in contact above, at its lesser curvature, with the diaphragm, the left lobe of the liver, and the lobulus Spigelii; at its great extremity with the spleen, at its posterior face with the pancreas, and at its greater curvature, with the colon and the mesocolon.

The stomach is formed by four Coats or laminæ, of a character essentially differing from each other: the Peritoneal, the Muscular, the Cellular or Nervous, and the Mucous.

The Peritoneal Coat envelops the stomach completely, and adheres closely, except at the curvatures, where, as has been mentioned, a provision is made for the distension of the organ, by the looseness and the separability of the attachment of the two laminæ of the omentum minus and of the majus. An uncovered space will consequently be found between the laminæ at these places, along which the vessels run that furnish the stomach. The peritoneal coat is very thin, and is attached to the subjacent muscular, by very fine cellular substance, which permits it to be raised from the muscular by a careful dissection. In a dried preparation which I made,[1] there is an exhibition of minute foramina of the peritoneal coat, already alluded to in the article on serous membranes, in apposition nearly as close as the follicles of the mucous coat. The attending plate, the drawing for which was made by Dr. Leidy from nature, exhibits well the appearance of the piece.

Fig. 160.



Organized Pores in the Serous Coat of Stomach, from the 1-40th to the 1-8th of a line in diameter, naturally.

The Muscular Coat is intermediate in thickness to that of the intestines and of the œsophagus, but its fibres are pale, are collected into flattened fasciculi, and go in three directions. The most superficial are a continuation of the longitudinal fibres of the œsophagus, and are less numerous and less uniform in their distribution than the circular fibres. The greater part of them form a flattened broad fasciculus, which extends along the lesser curvature of the stomach, from the cardiac to the pyloric orifice. A thinner and less distinct fasciculus may be traced over the great cul-de-sac, and somewhat indistinctly along the

[1] In 1839.

greater curvature; and a few others may be seen on the anterior and posterior faces of the stomach, forming rather a fine linear or striated appearance than a perfect lamina; this linear appearance is well exhibited by an oblique reflection of light from it. The second series consists in a lamina of circular fibres distinctly covering the whole extent of the organ. They are not so numerous near the cardia, but become more abundant as they are examined towards the pylorus; in the vicinity of which they are multiplied so as to form a lamina of two lines or more in thickness. The circular fibres are parallel with each other; and when the stomach is much distended, their fasciculi separate so as to leave interstices between them in many places. The individual fibres do not surround entirely the stomach, but are rather segments of circles. The third and deepest series of fibres, constituting the muscle of Gavard, from their discoverer, may be called oblique, and are arranged into two broad flattened fasciculi, one of which is placed to the left side of the cardia, and is prolonged over the anterior and the posterior face of the stomach; while the other, being to the right of the same orifice, is extended over the anterior and the posterior face of the great cul-de-sac, where it supplies the want of transverse or circular fibres. This third series may be considered as a continuation of the circular fibres of the œsophagus.

The Cellular or Nervous Coat (*Tunica propria*) connects the muscular with the mucous. It is formed by a compact, thick, and short cellular substance, which, when inflated and dried, looks like carded cotton. It contributes much to the general strength of the organ, and serves to conduct the blood-vessels and the nerves to the mucous coat.

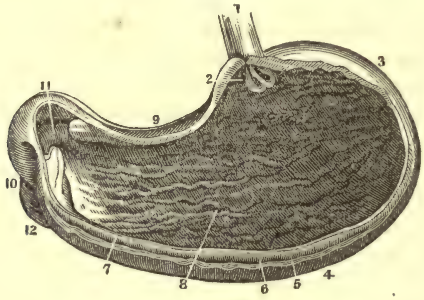
The Mucous or Villous Coat is the most internal, is scarcely half a line in thickness, and can be readily raised up by dissection, and, if prepared in spirits of wine, can be rolled off. In an undistended state of the stomach, it is arranged into a number of wrinkles, which are very irregular in their form, size, and direction, but disappear immediately on distension, or at least leave but very faint traces. It is continuous with the internal membrane of the œsophagus and duodenum, but presents a surface differing from either of them, and which is rendered very apparent by floating it in water. The epidermis, which is continued along the internal face of the œsophagus, ceases, as mentioned, around the cardiac orifice, and, by slight maceration, may be raised up and demonstrated to terminate there.

An epithelium under modified circumstances is then found to start, and to cover the entire interior of the stomach, and to be continued over the intestinal canal from one end to the other. It is softer, thinner, and more spongy than the common epidermis of the pharynx and œsophagus, but may be proved to exist by the microscope, by the exfoliations in scales found in the fæces, and also by insufflation, when it will be raised and may be dried in that state.

This mucous membrane or coat, the office of which is to secrete the gastric juice for the digestion of articles of food, presents a surface that resembles very much common velvet, from whence the term villous is

applied to it. If it be perfectly healthy, and the individual died suddenly a few hours after eating, it is found of a uniform light pink color, without blotches or anything of extravasation under it. This fact I have had several opportunities of verifying by experiment and by

Fig. 161.



A View of the Interior of the Stomach, as given by the removal of its Anterior Parietes.—1. Œsophagus. 2. Cardiac orifice of the stomach. 3. Its greater extremity, or cul-de-sac. 4. The greater curvature. 5. Line of attachment of the omentum majus. 6. The muscular coat. 7. The anterior cut edge of the mucous coat. 8. The rugæ of the mucous coat. 9. The lesser curvature. 10. The beginning of the duodenum. 11. Pyloric orifice, or valve. 12. The first turn of the duodenum downwards.

autopsies:[1] and more lately in the person of a criminal, Williams, executed for murder.[2] It is usual to find it, if examined a short time after death, having, particularly along the smaller curvature and at the great end, a pink and sometimes a deeper color, produced by an accumulation of blood in its veins.

The texture of this membrane is soft, loose, and easily lacerated. When floated in water and examined with a magnifying glass, it is found to have a superficial honey-comb arrangement, and to be studded with a multitude of Crypts (*Cryptæ*), they being small follicles or orifices, whose number is above fourteen thousand to the square inch, and whose diameter varies from the fortieth to the eighth of a line. In the vicinity of the cardiac and of the pyloric orifice, the same arrangement is more obvious, and exhibits also some small glands, which are more or less apparent, and called the glands of Brunner, being by some considered muciparous, and by others as the source of the gastric fluid.

At the junction of the lesser extremity of the stomach with the duodenum, the internal membrane is thrown into a circular duplicature constituting the Pyloric valve, and abridging the size of the orifice. It is seen most distinctly in the distended and dried state, and then presents a sort of septum not unlike the form of the iris. Around the external periphery of this ring, the circular muscular fibres have an abrupt augmentation of number, which gives them, when viewed from the duodenum, the appearance of a distinct circular muscle, occasionally called the muscle of the pylorus, but it does not exist in a state so separate as this name indicates. The opening of the pyloric valve is generally circular, but sometimes ovoidal, and it is sometimes to one side.

[1] See Amer. Journal Med. Sciences, vol. i. 1827; Horner's Pathol. Anat. p. 195, &c.
[2] Aug. 9, 1839.

It is very common to find the stomach divided, as it were, into two chambers, by a contraction of its middle, resembling that of an hourglass. It is said that this occurs habitually during digestion; in my personal observations, however, I have seen the stomach more frequently in this state when it contained nothing, not even air, than when articles of aliment were in it.

The stomach is extremely vascular. Its arteries, being branches of the Cœliac, are the Gastric, the Right and the Left Gastro-Epiploic, and the Vasa Brevia. The first goes along its lesser curvature; the second and the third along its greater curvature; and the last, from four to six in number, go to its great cul-de-sac. They all approach it between the laminæ of its omenta, and undergo many divisions and subdivisions in the cellular coat; they at length terminate by forming a very fine and delicate vascular arrangement in the substance of the mucous membrane, and when successfully injected give to the latter a thorough tinge of red. The veins follow the course of the arteries, and like them have frequent anastomoses, but are larger; they terminate either directly or indirectly in the trunk of the Vena Portarum. The attending plate, drawn by Dr. Leidy from an injection of mine, exhibits the veins of the stomach, as seen with a microscope, on the mucous coat.

Fig. 162.

Reticular arrangement of veins to form the mouths of the mucous follicles of the stomach. Natural diameter of meshes from the 1-40th to the 1-8th of a line in diameter.

Its lymphatics arise from both the external and the internal surface, and their trunks, having to pass first of all to the lymphatic glands situated along the curvatures, afterwards empty into the thoracic duct.

The nerves of the stomach come from the Par Vagum, and from the semilunar ganglions of the Sympathetics.

SECT. II.—OF THE INTESTINAL CANAL.

The Intestinal Canal is from thirty to thirty-five feet in length, and extends from the pylorus to the anus. Owing principally to a well-marked difference in magnitude, it is divided by anatomists into the Small and into the Large Intestine.

The Small Intestine, though an uninterrupted tube from one end to the other, is divided by anatomists into Duodenum, Jejunum, and Ileum. There is some reason for the first name; but the two latter may be

very conveniently blended, as has been done by some, under the term Mesenteric Portion of the Intestinal Canal. The Large Intestine consists in the Cœcum, Colon, and Rectum.

Of the Small Intestine.

The Small Intestine (*Intestinum Tenue*) commences at the pylorus, and terminates in the right iliac region by a lateral aperture into the large intestine. It is four-fifths of the length of the whole canal, and measures from twenty-four to twenty-eight feet.[1] When moderately distended, its diameter is about one inch. It retains from one end to the other an uninterrupted cylindrical shape, with the exception that if the two ends be compared, the upper will be found larger than what is stated as the medium measurement, and the lower smaller; by which arrangement it occurs that the intestine decreases successively from above downwards, and, as a whole, is slightly conoidal or spindle shape, though this diminution is so gradual that it is not perceptible in any short space.

The Small Intestine, like the stomach, consists of four distinct coats, the peritoneal, the muscular, the cellular, and the mucous.

The Peritoneal Coat is complete, and forms the external surface. It is continued afterwards in two laminæ from the intestine to the lumbar vertebræ, thereby constituting the Mesentery. The two laminæ, where they depart from the intestine, are loosely connected with each other, for the purpose of allowing room for the dilatation of the intestine, on the same principle which is exemplified in regard to the stomach. It is very delicate, and adheres by sparse thin filaments of areolar tissue to the muscular.

The Muscular Coat is next to the peritoneal. Its fibres are pale, and form a lamina not so thick as common writing paper. The superficial ones are longitudinal, not very distinct, and too much separated to form a perfect coat; they are most abundant on the anterior semicircumference or the one most distant from the Mesentery. The others all run in a circular direction, approaching to the spiral, and are sufficiently numerous to form a perfect coat: none of them perform a complete circuit of the intestine, but are rather segments of circles. This coat is united to the peritoneal by a thin scattered cellular substance, as stated.

The Cellular Coat of the small intestine (*Tunica propria*), also called the Nervous, like that of the stomach, is only a lamina of dense filamentous cellular substance, which serves as a medium of connection

[1] This is the generally received opinion of anatomists: it would appear, however, to be applicable only when the intestine is left attached to the mesentery; for, if it be cut off and straightened, it will measure thirty-four feet, which, added to eight feet of large intestine treated in the same way, will amount in all to forty-two feet. If to the estimate of this length we add what is lost by the doublings of the mucous coat, the length of surface must amount to nearly sixty feet; at least, in many subjects.

between the muscular and the mucous coat: and also conducts to the latter the blood-vessels, nerves, and lacteals. When inflated and dried, it puts on a beautiful cotton-like appearance, just as the corresponding coat of other parts of the alimentary canal does under the same treatment.

In the lion this membrane presents a most elegant clear tendinous appearance, and is so strong that it will bear, from the interior, the pressure of a column of water eighteen feet high, the muscular and peritoneal coats splitting open, while it remains entire. Under this strong pressure of water neither the lacteals nor blood-vessels are filled with it, which goes to prove that the introduction of articles into them, from the intestinal cavity, is a vital and not a physical action.

The Mucous Coat is the most internal, and when it has been cleaned by maceration, exhibits an opaque pearly color. It is remarkable for having its extent very considerably augmented beyond that of the other coats, by being thrown into a great number of permanent folds, or duplicatures; which lie one upon another successively, like the shingles upon the roof of a house. These duplicatures are the Valvulæ Conniventes, and are for the most part about three lines in breadth. They are either placed in the direction of the circumference of the intestine, or are very slightly oblique; generally they go all around, but many of them are segments of circles, and by being arranged successively, their ends pass one another, or are connected by slight elevations. They are more numerous and broad in the upper than in the lower half of the intestinum tenue, and are evidently intended to retard the progress downwards of alimentary matter, and to increase the surface for absorption and for exhalation.

Fig. 163.

A Longitudinal Section of the upper part of the Jejunum extended under water. 1, 1. Valvulæ conniventes. 2, 2. The summits of two of the valvulæ placed side by side. The villi cover the whole membrane, but are best seen on its edges in this cut.

The mucous membrane, on the side which it presents to the cavity of the intestine, is furnished with a great number of delicate cylindrical projections, resembling the down on the skin of an unripe peach,

and called Villi,[1] from whence the term villous has also been applied to this coat. These villi are to be found in abundance everywhere; but in the upper half of the intestinum tenue they are so numerous as to stud its whole surface, and to be in contact with each other. They are from one-fourth to a line in length; and some of them, when examined with a microscope, appear flattened and fungiform. According to the estimate of Meckel,[2] where they are thickest, every square inch of intestine furnishes about four thousand of them, and by extending this computation, with a proper allowance for diminished numbers below, their aggregate amount is about one million.[3]

Each Villus is composed of an artery, a vein, and a lacteal absorbent; all united by cellular substance. From the extreme vascularity of the

Fig. 164.

Magnified view of the Blood-vessels of the Intestinal Villi, showing an artery and vein, and a superficial capillary net-work. After a preparation injected by Lieberkühn.

mucous membrane, the blood-vessels readily receive a fine injection, and thereby become evident, forming a very delicate vascular net-work in each of the villi. It is generally believed, that the absorbent opens on its surface, but whether by one or more orifices is yet unsettled. According to the celebrated Lieberkühn, there is commonly but one orifice at the end of each villus, and very rarely two: this assertion he considered himself as having established by passing a current of air through the villus till it was dried, and then slitting it open. Hewson, Cruikshank, and W. Hunter, on the contrary, are said to have found many more, amounting even to twenty, on such villi as were gorged with chyle. The subject has been fruitful in controversy to anatomists, and ranks many distinguished champions on each side; but from the minuteness of the parts under discussion, it is exposed to much fallacy and illusion, and is not as yet fully settled. The more important fact, however, is conceded by the admission of all, that there is a branch of the absorbent system in every villus, and which has, for its function, the absorption of chyle from the cavity of the intestine.

[1] This is intended merely as an expression of the common and received notion. My own views are exhibited in the article on the minute anatomy of this coat.

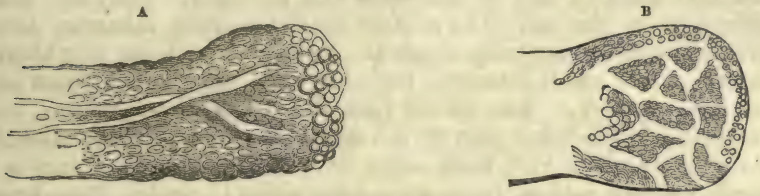
[2] Manuel d'Anat.

[3] This is probably much below their real number; in an observation at the University we have found the villi on the ileum at its lower part amounting to six thousand four hundred to the square inch; but as their shape varies very much, as we shall see, a rule cannot be derived from the shape.

A more recent observation has been made by Professor Krause[1] in the body of a young man who had been hung after taking a full meal, where he found the villi of the jejunum beautifully filled with chyle. The lacteal of each villosity arose by several branches, of which some terminated by a free extremity, and others by anastomosis with each other. Judging from his plate, he does not appear to have traced any branch to the surface of the villus. Müller says that he himself had never seen any opening at the extremity of the villi. Béclard, Meckel, and Rudolphi have also never seen patulous orifices of lacteals on them, and disclaim the existence of such. This corresponds with my own experience, as I have also, in one case, had a fine opportunity of seeing them distended with chyle.

This problem may be considered as having received some elucidation in the observations of Mr. J. Goodsir.[2] He has found, at the end of the villus, a cluster of cells from the $\frac{1}{2000}$th to the $\frac{1}{1000}$th of an inch in diameter. The origin of the lacteal is a net-work in the midst of them.

Fig. 165.



Extremity of Intestinal Villus; seen at A, during absorption, and showing absorbent cells and lacteal trunks, distended with chyle; at B, during interval of digestion, showing peripheral net-work of lacteals, with granular germs of absorbent cells, as yet undeveloped, lying between them.

When digestion is suspended, the villus is flaccid, and the cells are merely granular germs; but when digestion is resumed, the cells begin to develop themselves; they grow; select, absorb, and prepare the nutritious matter, and make it a part of themselves. This accomplished, they deliver their contents to the lacteals by their own dehiscence or solution, which it is suggested may at the same time set free the succeeding generation of germs to go through the same process. If Mr. Goodsir's observations be correct, they will no doubt also apply to other surfaces of the gastro-intestinal mucous membrane.

The villi, however, under any circumstances, cannot be considered as the sole organs for the absorption of chyle, for in many animals they do not exist.[3] A more calm inquiry into this matter will, probably, bring us to the conclusion that the villi exercise a tactile as well as an absorbing power, which office their strong analogy with the papillæ of the cutis vera strongly points out. If we bear in mind, also, that there are no villi to call such in the stomach and in the colon, it will go to prove that they are simple doublings of the mucous coat, and exercise no exclusive power of absorption.

An abundance of Mucous Glands is found deposited in the cellular

[1] Müller's Archives, 1837. [2] Carpenter's Pr. Human Physiol. p. 144, Phil. ed. 1850.
[3] Müller, Physiol., pp. 287, 288.

coat of the small intestine, between the muscular and the villous; their ducts open upon the internal surface of the latter, in the interstices of the villi, and from their smallness require the intestine to be floated in water, and examined with a magnifying glass, before they can be recognized. In order to see the glands themselves, the intestine must be cleaned by soaking it in water; it is then to be slit open longitudinally, and held between the eye and the light, in which case the glands appear like little points or spots in the thickness of the intestine. They are more abundant in the beginning of the latter, decrease about its middle, and increase again towards its termination. Their structure is very simple, as they consist in a congeries of blood-vessels, terminating on short canals secreting mucus.[1]

Some of these glands are microscopical, and are crypts (*cryptæ*): they appear as extremely fine cul-de-sacs, or blind pouches, made by inflections simply of the mucous coat, and are at the rate of near twenty-five thousand to the square inch, with a diameter varying from about the fortieth to the twentieth of a line. Other glands are to be found from that size to a line in diameter, and flattened. They are either solitary or in clusters. The solitary kind (*glandulæ solitariæ, Brunneri*), are found principally about the duodenum and the neighboring portion of the small intestine, but also exist all the way down in a scattered manner. The others (*glandulæ agminatæ Peyeri*), exist principally in the lower part of the small intestine, and are collected into clusters which vary from a few lines to three or four inches in length, but are seldom more than from eight to twelve lines broad. They are, for the most part, in elliptical patches, which, in a healthy state, may be recognized rather by a slight discoloration, than by the more ordinary means, and are generally situated some distance from the mesentery. There are about thirty of these clusters, of all sizes, in the ileum, and they are placed nearer and nearer to one another, in approaching the ileo-colic junction. All of these glands of Peyer are too much flattened to project sensibly into the cavity of the intestine, and, when they do, there is reason to believe that they are in a diseased state, at least in the adult. For the most part, in children, the glands of Brunner may be seen without difficulty, in the whole length of the small intestine, and in adults some are found to project like little hemispherical grains at wide intervals apart into the duodenum.

The mucous coat of the small intestine is everywhere extremely vascular.

The Duodenum, named from its being about twelve inches or twelve fingers' breadth in length, is nearest to the stomach, and is the commencement of the canal. It is considerably larger than either of the others, and is, moreover, susceptible of great dilatation, whence it has also been called Ventriculus Succenturiatus. Its direction is much varied; beginning at the pylorus, it first of all passes upwards and to the right side till it reaches the neck of the gall-bladder; it then turns downwards, so as to form a right angle with itself, and descends in

[1] Sœmmering, de Corp. Hum. Fabrica.

front of the right kidney to the third lumbar vertebra, being there placed behind the superior lamina of the transverse mesocolon. It then forms a round elbow, crosses the spine obliquely, under the junction of the mesentery and mesocolon, in ascending from right to left; and, making its appearance to the left of the second lumbar vertebra, is there continued into the mesenteric portion of the intestine.

The beginning of the duodenum is movable, and has a peritoneal coat continued from the lesser omentum; the descending and the transverse portions have no proper peritoneal coat, but are only loosely fixed between the laminæ of the mesocolon. The termination of the duodenum is both movable and has a peritoneal covering, from being at the commencement of the mesentery.

From the course assigned to the duodenum, it is evident that it forms the segment of a circle, the concavity of which looks to the left side. This concavity is occupied by the head of the pancreas. The transverse portion crosses the spine below the pancreas, and is separated from it by the superior mesenteric artery and by the vena portarum: behind it are the crura of the diaphragm, the ascending cava, and the aorta.

The organization of the duodenum is the same with that of other portions of the intestinum tenue. Its peculiarities consist only in a partial deficiency of peritoneal coat, and in its augmented size. Its internal or mucous coat is very much tinged with bile, abounds in valvulæ conniventes, especially in its inferior three-fourths, and about four inches from the pylorus is marked by a small tubercle or elevation indicative of the common orifice of the biliary and pancreatic ducts. The solitary Glands, or those of Brunn, commonly called Brunner, are very conspicuous in this intestine on raising its mucous coat, and are so numerous near the pyloric orifice, as to form with some a perfect layer, and to give it a granulated appearance for two inches or more. These glands, originally called the Secondary Pancreas by Brunn, are also considered by M. Cruveilhier and Boehm to be pancreatic in their structure. This idea was first inculcated by their discoverer,[1] who considered them to secrete a peculiar liquor, but thought that the action of the pancreas, if it were exterminated, would easily pass to them,[2] hence his appellation to them of Pancreas Secundarius.

The Jejunum and Ileum form the remaining length of the small intestine, and have no external marks of difference from each other. They are strung along the mesentery, and, in consequence of their great length, are thrown into folds or convolutions, which give to them a complicated appearance. There is, however, no difficulty in tracing them regularly from one end to the other. They occupy the umbilical, the hypogastric, and a part of the iliac regions, and are surrounded by the circuit of the colon. The upper two-fifths is the jejunum, and the lower three-fifths the ileum. This distinction, originally introduced by Galen,[3] from a supposition that the jejunum was more frequently found empty than any other intestine, has no rigid anatomical support.

[1] J. Conrad, A. Brunn, Gland. Duodeni Seu Pancreat. Secund. Descriptio Anat., for which treatise in full see Mangetus, Theatr. Anat. t. i. p. 276, Geneva, 1716. The other glands of Brunner found all the way down the small intestine, are evidently different from these in being more spherical, always solitary, and small in comparison.

[2] Id. p. 291.

[3] Portal, Anat. Med.

The only difference between the two is that the valvulæ conniventes, existing as they do in the whole length of the jejunum, become less abundant at the upper part of the ileum, and finally disappear entirely towards its lower extremity. They decrease indeed very sensibly at the lower part of the jejunum, and sometimes there are none at all in the ileum. In an observation made carefully on this matter by detaching the intestine from the mesentery—inverting it and then measuring—I found the valvulæ conniventes to cease as near as may be, in the middle of the length of the mesenteric portion of the intestinal canal. The above distinction into jejunum and ileum has been rejected by some of the most approved modern authorities, such as Haller, Sœmmering, and Meckel.

It sometimes happens that the intestinum tenue has one or more blind pouches like cœca appended to its sides and opening into its cavity.

The small intestine is supplied with blood from the superior mesenteric artery. Its nerves come from the sympathetic.

The Mesentery (*mesenterium*) is a process of peritoneum which serves, as mentioned, to connect the intestinum tenue to the posterior parietes of the abdomen, and extends its connections from the left side of the second lumbar vertebra to the right iliac fossa. This attachment, called the root, is about six inches in length; whereas, its lower circumference, which encloses the small intestine by giving it a peritoneal coat, is, of course, the whole length of the bowel (duodenum excepted), and, consequently, from twenty-three to twenty-seven feet in length. This expansion becomes intelligible the moment that the arrangement of the part is inspected, and is somewhat after the manner of a ruffle, except that it is not puckered at the root.

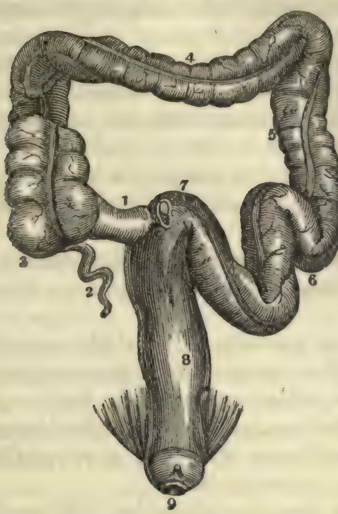
The two laminæ of peritoneum which form the mesentery, contain between them the superior mesenteric artery, and the corresponding portion of the superior mesenteric vein; an abundance of lymphatic or lacteal glands and vessels; ramifications from the solar plexus of the sympathetic nerves; and a considerable quantity of cellular and of adipose tissue. The superior lamina is continued directly into the mesocolon, and at the place of junction the transverse part of the duodenum is very perceptible beneath. The lower lamina descends along the posterior parietes of the abdomen, concealing the large blood-vessels there, and the ureters.

Of the Large Intestine.

The Large Intestine (*intestinum crassum*) receives the effete matter from the small, and is supposed also to make some peculiar secretion of fecal matter from its internal surface. It exceeds much in its diameter the small intestine, and differs also from it in not being by any means so nearly cylindrical. It commences at the inferior end of the small intestine, and terminates at the anus, describing in this course, as mentioned, a circle which surrounds two-thirds of the abdomen, and embraces the intestinum tenue. Like the latter, though only a continuous tube, it is divided into three parts; the commence-

ment of it, which is below the insertion of the ileum, and about two inches in length, is the Cœcum, or Caput Coli; the remaining portion, which occupies almost its whole length, is called the Colon, until it reaches the brim of the pelvis, when the name is converted into Rectum.

Fig. 166.



A view of the Position and Curvatures of the Large Intestines.—1. The end of the ileum. 2. Appendicula vermiformis. 3. The cœcum, or caput coli. 4. The transverse colon. 5. The descending colon. 6. The sigmoid flexure. 7. Commencement of rectum. 8, 8. The rectum. 9. The anus.—The levator ani muscle is seen on each side.

The Mesocolon is a reflection or duplication of peritoneum, that fixes the large intestine to the posterior parietes of the abdomen. This duplicature is not of a breadth so uniform as the mesentery, but allows to the middle of the large intestine very considerable motion, up and down, according to the distension of the stomach, while the lateral portions are very much confined. For instance, in the right iliac fossa the mesocolon is so short that the posterior surface of the gut is in contact with the iliac fascia, and adheres to it by loose cellular substance; and in the right and left lumbar regions the bowel is immovably fixed in front of the kidneys near their outer margin; but in the space between these two points, that is to say, where the bowel traverses the hypochondriac and the epigastric or the umbilical region, the peritoneal attachment, here called, from its situation, the transverse mesocolon, is so long and so loose that it forms a complete and movable septum between the small intestine and the stomach. In the left iliac region, again, the large intestine, after having been bound down to the left lumbar, is suddenly loosened by an increased breadth of the mesocolon, which permits it to form a large convolution, called its sigmoid flexure. The mesocolon is then continued into the pelvis in front of the sacrum, first of all to the left of the middle line of the latter, until it gets near the centre of the sacrum, whence it descends directly in front of its middle line. The portion of this attachment of the large

intestine in the pelvis is called meso-rectum, from the gut which it serves to attach.

The composition of the mesocolon is precisely the same with that of the mesentery, though it be not so thick: it, therefore, consists in two laminæ of peritoneum, which contain between them some adipose and cellular matter, along with the arteries, the veins, the nerves, and the absorbent vessels and glands belonging to the large intestine.

When the large intestine is inflated, it is rendered very obvious that it decreases in size from its commencement to the lower part of the sigmoid flexure; it increases again in size just above the anus. Its surface is arranged into three series or longitudinal rows of projections, separated by transverse depressions, the whole corresponding with an internal cellular arrangement, by the latter surface being the reverse of the former.

Its coats, like the small intestine, are four in number; the peritoneal, the muscular, the cellular, and the mucous.

The Peritoneal Coat prevails in its whole extent, with the exception of the lower part of the rectum: on the ascending and the descending portions of the colon, however, where the latter comes in contact with the parietes of the abdomen, the peritoneum does not invest it entirely; but the transverse portion or the arch, as it is called, and the sigmoid flexure, are completely surrounded.

The surface of this intestine is studded with small projections of various lengths, called Appendices Epiploicæ, which are small duplicatures of the peritoneal coat containing fat.

The Muscular Coat is thin, but stronger than that of the small intestine, and consists of two orders of fibres, the longitudinal, and the transverse or circular.

The longitudinal fibres have the peculiarity of being collected into three equi-distant, flattened fasciculi or bands, of about half an inch in breadth, which begin by a common point at the extremity of the cœcum, or base of the appendix vermiformis, and extend to the upper end of the rectum. One of them is along the line of junction with the mesocolon. These fibres, being shorter than the other coats of the gut, have the effect of puckering it into the internal cellular condition alluded to; for, when they are cut through, the intestine is much elongated, and its cells disappear. It occasionally happens that the longitudinal fibres, instead of being confined to the bands mentioned, exist in considerable quantity over the intermediate spaces; in this case the cellular arrangement is not so complete, and in some instances is entirely dispensed with; of the latter, an example is in the Anatomical Museum.

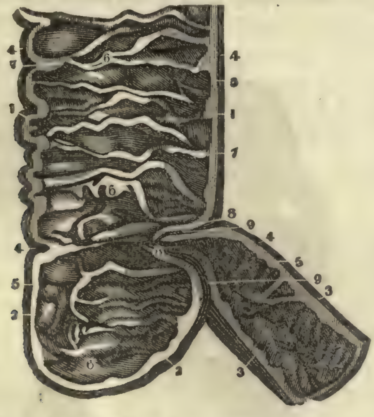
The circular muscular fibres form a thin semi-transparent lamina beneath the last, and do not present any peculiarity of interest; they make a thicker layer than exists in the small intestine. About the sigmoid flexure they may be seen as a double layer, to the exterior of which two, the longitudinal fasciculi adhere and may be raised up with it if we remove at the same time the peritoneal coat.

The Cellular Coat, or Tunica Propria, is a thin lamina of dense filamentous cellular substance, serving to connect the muscular with the mucous coat, and to conduct the blood-vessels and nerves to their terminations on the latter. When inflated and dried, it looks like cotton.

The Mucous Coat lines smoothly the internal face of the cellular, and has no doublings or folds, exclusively in it, like the valvulæ conniventes of the small intestine.[1] The transverse projections which it makes between the longitudinal bands, into the cavity of the gut, and which separate the cells of the large intestine from each other, are not mere duplicatures of it alone, but are also constituted by the other coats.

Near its commencement this coat has the fungous appearance of the stomach, but about the sigmoid flexure it has a plain, smooth, and, to a degree, a polished surface. It has but few villi, such as exist in the small intestine; indeed, some anatomists deny that it has any, and I have not myself seen them after repeated and careful examinations. Its muciparous glands are numerous, and, when somewhat enlarged, project; they are very conspicuous about the sigmoid flexure, and in the rectum. The enteric follicles, or crypts (*cryptæ*), also exist in the large intestine strikingly, as they do in the mucous coat of the stomach and small intestine. Their number, on an average, is about twenty thousand to the square inch, with a diameter varying from about the fortieth to the twentieth of a line. When examined with a microscope,

Fig. 167.



Longitudinal section of the end of the Small Intestine, or Ileum, and of the beginning of the Large Intestine, or Colon.—1, 1. A portion of the ascending colon. 2, 2. The cœcum, or caput coli. 3, 3. Lower portion of the ileum. 4, 4. The muscular coat, covered by the peritoneum. 5, 5. The cellular and mucous coats. 6, 6. Folds of the mucous coat at this end of the colon. 7, 7. Prolongations of the cellular coat into these folds. 8, 8. Ileo-colic valve. 9, 9. The union of the coats of the ileum and colon.

they make this mucous membrane, owing to its smoothness, look like a riddle. The lacteals are not abundant.

The mucous coat of the large intestine is very vascular, but not so much so as that of the small intestine.

[1] This may be considered as the general rule: if the gut be examined, however, in its whole length, here and there narrow folds may be found in some subjects.

Each division of the large intestine has some peculiarities of structure and connections, which may now be attended to.

The Cœcum, or Caput Coli, is generally from an inch and a half to two inches long, has a rounded termination below and somewhat to the left, from which proceeds an intestinal process, the Appendicula Vermiformis. The latter is from three to four inches long, is cylindrical, has a diameter of two or three lines, and consists of the same number of coats, having the same structure with other portions of the intestinal canal; its base is the place from which the three longitudinal bands start. It is attached to a narrow duplicature of peritoneum, a process of the mesentery, which permits it to float loosely in the abdomen. It seldom contains feces, but is kept distended by flatus. Its crypts are considered by Dr. Neill to be more diversified than those of the colon.[1]

The cœcum, as mentioned, is, for the most part, confined to the right iliac fossa, but we very frequently see it with a length of peritoneal attachment permitting it to descend for a short distance into the lesser pelvis.

The Ileo-colic Valve (*valvula Bauhini*) is formed at the junction of the ileum with the caput coli. This valve, destined to prevent the return of fecal matter from the large into the small intestine, consists in a transverse elliptical opening, or slit, whose two lips become approximated in the distensions of the colon. The ileum runs into the left wall of the large intestine, and continues its cellular and mucous

Fig. 168.

A view of the Cœcum, after it has been distended, dried and laid open in front. 1. The ascending colon. 2. One of the cells of the colon. 3. The ileo-colic valve. 4. The opening into the appendicula vermiformis. 5. Appendicula vermiformis. 6. A section of the lower end of the ileum.

coats into the corresponding coats of the latter. The circular fibres of the large intestine separate to a certain degree to permit this intro-

[1] See Med. Examiner, Feb. 1851, Phila.

duction, but their farther separation is restrained at each commissure or corner of the lips, by a blending of the structure, aided by a few ligamentous fibres, designated as the retinacula of Bauhin or of Morgagni; which, however, are frequently not very distinct. This separation is also restrained by the two longitudinal bands between which the lips are placed, one of which bands is at the posterior commissure, and the other only a short distance from the anterior. The lips themselves, formed principally by the mucous membrane, approach one another after the manner of the ship dock or canal gate; the superior is somewhat broader than the inferior. Their power, as well as their existence, depends entirely on the tension which is kept up by the natural connections of the parts; for a very slight dissection causes them to become almost effaced, and instead of forming an elliptical transverse opening, to be converted into a round patulous one.

The Colon, properly speaking, has some regional distinctions which are serviceable to accurate description. The right lumbar colon, which is bordered in front by the small intestine, and behind by the right kidney, extends from the ileo-colic valve to the margin of the false ribs of the corresponding side. The transverse colon, bordered above by the stomach, and below by the small intestine, goes from one hypochondriac region to the other. The transverse mesocolon is attached at its inferior longitudinal band, and the omentum majus along its superior band. It is generally found more distended than the other portions. The left lumbar colon descends from the hypochondriac region of the left side to the sigmoid flexure, being bordered behind and to its right margin by the left kidney, and in front by the small intestine. The sigmoid flexure, placed in the left iliac fossa, forms a convolution, but is very indifferently described by the term applied to it. It is occasionally very long and loose, and terminates at the left sacro-iliac symphysis. It is not unfrequently found destitute of the partitions which prevail in other parts.

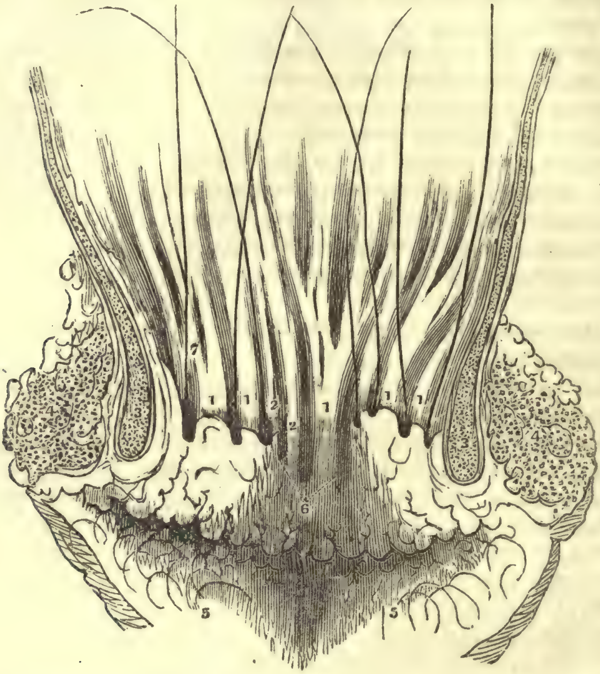
The Rectum begins at the left sacro-iliac symphysis, and passes obliquely downwards to the centre of the sacrum, thence in front of the middle line of the sacrum, and of the coccyx, to terminate near the point of the latter. It is not regularly cylindrical, but, just above the anus, is dilated into a wide pouch, flattened from before backwards by the pressure of the bladder, and very distinguishable upon the introduction of the finger, for it is but seldom in a contracted state. It of course has a flexure by adapting itself to the concavity of the sacrum, and is bounded in front by the bladder, the prostate gland, and the vesiculæ seminales of the male; and by the vagina and the uterus of the female.

The peritoneum covers only the superior two-thirds of the rectum, and attaches it by the short duplicature, called the mesorectum, to the front of the sacrum. A small pouch, passing down between the vesiculæ seminales almost to the base of the prostate, is formed, as mentioned previously, by the peritoneum in its course from the rectum to the bladder.

The muscular coat of the rectum has a thickness and redness surpassing much that of any other intestine, and is divided very clearly into

two laminæ, the external of which consists in longitudinal and the internal in circular fibres. The external forms in itself a complete coat

Fig. 169.



A vertical section of the Parietes of the Anus, with the Rectum, so as to show the relation of the rectal pouches to the surrounding parts, their orifices being marked by bristles.—1, 1. Columns of the rectum. 2, 2. Rudiments of columns. 3. Section of internal sphincter. 4. Section of external sphincter. 5, 5. Radiated folds of the skin on the surface of the nates. 6. Imperfect pouches. 7. Bristles in the rectal pouches.

continuous with the longitudinal bands of the colon, but is much increased in thickness over them by additional fibres. The circular fibres also form a complete coat, and, just below the pouch of the rectum, are multiplied so much for eight or ten lines as to be a perfect internal sphincter muscle, bearing a strong analogy with the pyloric one of the stomach.[1] At the anus, an arrangement of the muscular coat prevails, which is not sufficiently attended to by anatomists. The longitudinal fibres, having got to the lower margin of the internal sphincter, turn under this margin between it and the external sphincter, and then ascend upwards for an inch or two in contact with the mucous coat, or rather its cellular substratum, into which they are finally inserted by

[1] It has been recently asserted that there is also a sphincter muscle four inches above the anus, half an inch wide in front, and one inch wide behind, from whence, according to M. Velpeau, the fibres go in crossing one another to fix themselves to the front of the sacrum. M. Lisfranc appears to have first announced it, and M. Nelaton to have described it. Malgaigne, Anat. Chirurg. vol. ii., p. 343. Paris, 1838. I doubt very much the uniformity of the distinct existence of such a muscle, not having been able to find it in the dissections which I have instituted for the purpose, unless a portion of the ordinary circular fibres should have been selected for that designation, in which case several other sphincter muscles may be said also to exist.

fasciculi which form the body of the columns of the rectum; many of the fibres, however, terminate also between the fasciculi of the circular fibres. This connection must have obviously much influence in the protrusions of the mucous coat, which take place in hemorrhoids and in prolapsus ani.

The mucous coat of the rectum is thick, red, and fungous, and abounds in mucous lacunæ and glands. It is laid smoothly above, but below it is thrown into superficial longitudinal folds called columns. At the lower ends of the wrinkles, between the columns, are small pouches of from two to four lines in depth, the orifices of which point upwards; they are occasionally the seat of disease, and produce, when enlarged, a painful itching. An original observation of Dr. Physick, on the nature of this affection, and the remedy for which consists in slitting them open or removing them, induced me to look for the ordinary natural structure, which I have ascertained to be as now described.[1] The radiated wrinkling of the anus is from the influence of the external sphincter ani muscle.

In some subjects, large cells are formed in the cavity of the rectum by transverse doublings of the mucous coat only, resembling the valvulæ conniventes of the small intestine; this, however, is not the most frequent arrangement, though deserving of notice. It takes place under the following mechanism: About a finger's length from the anus there is a puckering of the gut, or deep wrinkling, on its outer periphery, such as occurs in the colon, and it arises from a similar cause, that is, an abbreviation of the longitudinal layer of muscular fibres of the gut: this abbreviation is not wholly circular, but occupies the semi-circumference of the gut on one side, and then, a little higher up, the semi-circumference of the other side. This shortening of the gut brings the fasciculi of its circular muscular fibres more together, and, therefore, accumulates then into a greater thickness. At a corresponding part on each side of the gut in its interior, exists a transverse doubling of the mucous coat forming the valvula connivens alluded to. The result of this arrangement is a semicircular valve on each side, one above the other, the margins or diameters of which pass each other, in the empty and contracted state of the rectum, but touching at the same time, and they present an additional barrier to the involuntary evacuation of feces.[2]

Most subjects, however, have the mucous coat without these valves, and merely in superficial wrinkles of various directions.

The large intestine is supplied with blood from a part of the superior

[1] See an interesting paper on Fistula in ano, by M. Ribes, in Mém. de la Société d'Emulation, vol. ix., 1826, where the influence of this structure is alluded to.—Also, an elaborate and excellent article by Dr. Reynell Coates, in the Cyclopædia of Pract. Med. and Surgery, Philada. 1835, under the term Anus. It appears that Glisson and Ruysch first described them as valves. The accurate Winslow (Douglas's Translation, vol. ii. p. 149, anno 1749) was also acquainted with this structure.

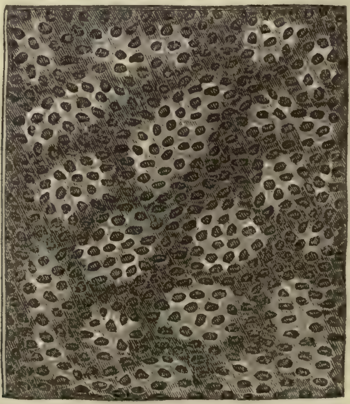
[2] It has latterly been advanced by Mr. O'Beirne that, in a natural state, the rectum is empty, and that the accumulation of feces preparatory to a stool occurs in the sigmoid flexure of the colon, where they are retained by a contraction of the upper end of the rectum. The principal ground of this opinion is that fecal matter is rarely met with in the rectum. The observation is so contradictory to my experience in the dissecting-room and on patients, that I cannot but reject it, though it appears to be obtaining some currency, or at least is quoted respectfully. Journal Hebd. 1833, vol. xiii. p. 126; Malgaigne, Anat. Chir. vol. ii., 341.

mesenteric artery, from the whole of the inferior mesenteric, and from the internal pudic. Its veins empty into the vena portarum. Its nerves are derived from the solar and the hypogastric plexus of the sympathetic.

SECT. III.—ON THE MINUTE ANATOMY OF THE MUCOUS COAT OF THE ALIMENTARY CANAL.

The mucous coat of the alimentary canal, in a healthy state, and successfully injected, appears to consist almost entirely of a cribriform intertexture of veins. These veins, being commonly empty at death, present themselves then as a soft spongy structure, which gives rise to the ordinary description of its sensible condition as a velvety layer. The most minute injection of the arteries scarcely makes itself visible among these veins when they are properly injected also; a straggling branch only here and there exhibiting itself. The arborescence of the arteries is confined to a level beneath the venous intertexture, and is there developed to an extreme degree of minuteness, being intermixed with corresponding venous ramuscles, generally larger and more numerous than the arteries themselves. This arrangement seems to occur in that surface of the cellular coat which makes the base or ground of the mucous. The fine venous trunks of this deeper layer have their originating extremities directed vertically towards the cavity of the gut, and by that means receive the blood of the first venous intertexture or layer, as the petrous sinuses join the cavernous, or the veins of the penis arise from its spongy structure. The meshes of the first venous intertexture are exceedingly minute, and vary in a characteristic manner in the stomach, small intestine, and large. This intertexture is very different in its looks from a common vascular anastomosis, and produces in the colon an appearance resembling a plate of metal pierced with round holes closely bordering upon each other; these holes constitute, in fact, the follicles of

Fig. 170.



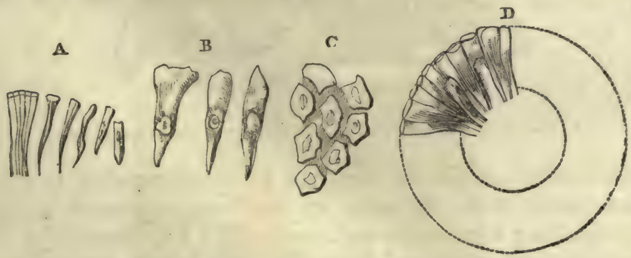
A view of the Follicles of the Colon, magnified about 115 diameters.

Lieberkühn, so called from their discoverer;[1] these *follicles* are gaping orifices, the edges of which are rounded off, and their depth is that of the thickness of the venous anastomosis; being bounded below by the *arterio-venous layer*, just alluded to, and by the cellular coat of the part. Nothing short of an entirely successful injection will exhibit this venous anastomosis as described; and it may be seen either by injecting a vein, or an artery, provided the injection passes from the arteries into the veins; but the latter process is the least desirable, because we lose the benefit of a distinction of color between the two sets of vessels.[2]

Ordinary modes of examination give no evidence of the existence in the alimentary canal, from the cardiac orifice of the stomach to near the anus, of an epidermis or epithelium; on the contrary, they rather lead to a belief of its being absent, in consequence of the softness, tenuity, and transparency of the mucous membrane; but that it is really present, may be proved by the following process: Tear off the peritoneal coat from a piece of small intestine—invert the part, and inflate it to an emphysematous condition; the epithelium will then be raised as a very thin pellicle, and may be dried in that state; but as this pellicle retains the air, we hence infer that it lines the follicles, and is uninterrupted by any perforations. This epithelium, if the part be previously injected perfectly, shows dots of injecting matter like those left in the rete mucosum upon a minute injection of the skin; but no arborescence of vessels if it be raised up from the veins, by the inflation stated. In so doing the villi disappear, as they are in fact unfolded.

In addition to the above proof, the microscope, in the hands of numerous modern observers, now shows, according to the original opinion of Lieberkühn, the existence of an epithelium over the whole alimentary canal, and which is formed of minute soft scales.

Fig. 171.



Cylinders of the Intestinal Epithelium, after Dr. Henlé.—A. Cylinders from the cardiac region of the human stomach. B. The same from the jejunum. C. Cylinders of the intestinal epithelium viewed by their free extremity. D. Ditto, as seen in a transverse section of a villus.

[1] De fabrica et actione Villor. intest. ten., Leyd. 1745.

[2] The observations more recently of Dr. Gaddi of Modena have resulted in witnessing a similar indisposition of the arteries to ramify in the mucous coat, and the almost exclusive prevalence of the venous vessels there. He has some views besides of a peculiar nature, such as that the extremities of the veins begin by open mouths on the cavity of the intestine, then unite to form a hollow sphere situated in the sub-mucous tissue, and that the terminating ends of the arteries discharge into these spheres or vesicles. Brit. & For. Med. Rev., Oct. 1841, p. 530.

The villi cannot be seen to full advantage except they be erected by an injection, in which case those of the upper part of the small intestine are found to run into each other very much like the convolutions of the cerebrum, and to press upon each other's sides in the same way. Some of them, however, are merely semi-oval plates, the transverse diameter of which exceeds the length or elevation. At the lower end of the small intestine they become simply conical projections, somewhat curved, with the edges bent in or concave, and they retain this mechanism until they entirely disappear near the ileo-colic valve. In the whole length of intestine there is, however, every variety of shape of villi, from oblong curved and serpentine ridges, to the laterally flattened cone standing on its base; the first condition changing gradually to the last in the descent of the bowel. Conformably to this definition of villi, none exist either in the stomach or colon, for there we have only the venous mesh.[1] The villi of the jejunum are about the thirtieth of an inch high, and those of the ileum about one-sixtieth.

In the ileum, the superficial venous layer has great regularity, and the conical villi stand out beautifully from its anastomoses, or, in equivalent language, from the divisions of the follicles. In the upper part

Fig. 172.

A view of the Villi and Follicles of the Ileum, highly magnified.

of the small intestine, the follicles are in equal number to what they are in the ileum; the regularity of their arrangements being interrupted by the long serpentine and oval villi; but invariably the same venous intertexture exists and forms, in both parts, the chief bulk of the villi, by passing into them.

In the stomach, the *follicles* vary much in size, and there is an arrangement whereby many of the smaller ones are seen to open into the larger: on an average, about two hundred and twenty-five are found upon every square of one-eighth of an inch, which would give of course to an inch square sixty-four times that amount, or fourteen thousand

[1] In the very successful injections of Dr. Neill made on young subjects, the villi of the pyloric orifice of the stomach are seen (*Am. Journ. of Med. Science*, Jan. 1851).

four hundred follicles. Conceding the whole stomach to present an area of ninety inches, which is probably below the mark when this

Fig. 173.

A view of the Folds and Follicles of the Stomach, magnified.

organ is moderately distended, as exhibited in the preparation upon which this calculation is founded, the entire number of follicles or cryptæ is *one million two hundred and ninety-six thousand.*

The great uniformity of size of these follicles in the colon, and its even surface, enable us to count them with more certainty, and they appear to exist at the beginning of this gut at the rate of about four hundred for every eighth of an inch square, but in the sigmoid flexure at the rate of about two hundred to the same area; they become, in fact, both smaller and less numerous in descending towards the anus. Their average may be stated, therefore, as three hundred for every one-eighth of an inch square—and as nineteen thousand two hundred for every inch square. Admitting the entire area of the colon to be five hundred inches, and nineteen thousand two hundred of these follicles to exist on every inch square, the aggregate number will be *nine million six hundred and twenty thousand.*

In the colon the resemblance is almost exact to what is called the perforated card or Bristol board, used by ladies for working embroidery or variegated needle-work.

Again, estimating the whole area of the mucous coat of the small intestine at fourteen hundred and forty inches, and allowing for interruptions occasioned by villi, about three hundred and ninety follicles exist upon every one-eighth of an inch square, or 24,960 upon an inch: say, then, that about twenty-five thousand follicles are found upon every square inch, and the two numbers multiplied produce *thirty-six millions.*

The entire number of crypts or follicles in the whole alimentary canal is, by the preceding estimates, *forty-six million nine hundred thousand*, and upwards. I am very far from pretending to have counted

them all, but have made an approximation to the actual number by observing sections of different portions of the same subject, and verifying the observations upon other subjects.

The external surface of the cutis vera presents, as it were, in outline, the same follicular arrangement; the venous reticular intertexture appearing broader, not quite so perfect, and more shallow, and forming the papillæ; but, as additional experiments are wanting, it may be passed over with this transient notice; perhaps, indeed, a more skilful hand in adopting the hint may perfect the details.[1]

In the stomach, the largest of these follicles is about one-ninety-eighth of an inch in diameter, and the smallest about one-four-hundred-and-ninetieth. In the colon, the largest is about one-two-hundred-and forty-fifth of an inch in diameter, and the smallest about one-four-hundred-and-ninetieth. In the small intestines, their size varies in about the same ratio as in the colon, but they are much more irregular in shape, being scattered more in groups, in consequence of the villi intervening; some of them penetrate obliquely towards the foundations of the villi; hence, when examined from the exterior, their distribution is more regular, and they are seen lodged in the cellular coat of the gut.

I have endeavored to keep the estimate of the number of follicles below what other calculators would make it, upon an observation of my preparations, and a fair measurement of the area of the alimentary canal, lest the number may seem excessive and incredible; I have, therefore, the most reasonable assurance of being within bounds on that point. I may now ask their use; is it to secrete or absorb? If they are simply secernents of mucus, the number one would think much greater than so limited a secretion requires—moreover, why is it that they become smaller and less numerous towards the lower end of the large intestine, where greater lubrication is required for hardened feces; in addition, are not the glands of Brunner (*solitariæ*), and of Peyer (*agminatæ*), amply sufficient to furnish the required mucus? Again, after most sedulous observations upon the villi of all kinds, finely erected by my injections, and placed under most accurate, simple, and compound microscopes, I find, invariably, a polished reflecting surface, uninterrupted by foramina, either at their ends or sides, while many of these follicles are found passing obliquely into their bases. An excellent microscope, which makes the villi of the ileum appear an inch long, exhibits them with a polished translucent surface, without foramina, except where a villus from accident has been broken, a contingency readily recognized by one in the habit of viewing them. Finally, if the lacteal foramina of Lieberkühn and others do really exist, why is it that the raising of the intestinal epidermis by inflation does not exhibit these foramina by the air escaping through them, but, on the contrary, admits of a dried preparation in that state, the villi being completely effaced?[2]

Taking into consideration these several objections to the theory of

[1] It is probably this which constitutes the bloody pimples (bourgeons sanguins) of the skin.

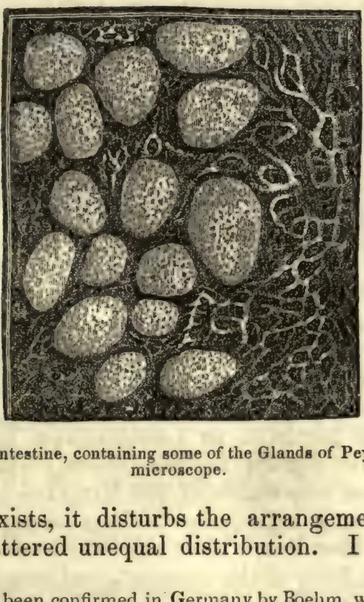
[2] In these and other microscopical observations, I owe much to my friend Dr. Paul Beck Goddard.

the follicles being secreting orifices, it appears to me that a better idea of their use is called for, which suggestion is submitted to the profession, with the hope that a more capable person will remove the difficulty, by additional confirmation of preceding theories, or by the invention of a new one; for my own part, I am much inclined to adopt the opinion of their absorbing faculties. It is generally conceded that the erection and prehension of the Fallopian tube are produced by a vascular turgescence, in which the veins, from their number, must execute an important part; in like manner, as these intestinal follicles are formed in the midst of veins, their orifices only become erect and patulous by the distension of those veins, and cannot be well seen by the eye alone, especially in the small intestine, unless an injection has succeeded fully; but the erection of these veins during digestion puts the follicles in a similar condition; and there is, therefore, some ground of inference, that the act of the Fallopian tube in conveying a germ, and of a follicle in conveying into the thickness of an intestine congenial matter, may be analogous.

The follicles would seem at least not to be essential to the secretion of mucus, as it is found where the follicles do not exist; for example, in the frontal, maxillary and sphenoidal sinus, and also in the cavity of the tympanum.

Notwithstanding the facility with which we can detect these follicles, I have failed entirely, under various means of examination, in finding any orifices to Peyer's glands in the dried intestine: they appear to be merely small lenticular excavations[1] in its substance, and wherever

Fig. 174.



A section of the Small Intestine, containing some of the Glands of Peyer, as shown under the microscope.

a cluster of them exists, it disturbs the arrangement of the villi, and gives to them a scattered unequal distribution. I would also suggest

[1] This observation has been confirmed in Germany by Boehm, who has come to the same conclusion. He says that they contain a white, milky, and rather thick fluid, with numerous round corpuscles of various sizes, but mostly smaller than blood-globules. Am. Journ. Med. Sc. vol. xxi. p. 218.

very respectfully to anatomists whether our knowledge in regard to them is sufficiently exact to render farther inquiry useless? For my own part, it appears that this subject requires some additional attention. As they are found closed, the probability is that their contents are discharged, when required, by a regular dehiscence.

The above view, relative to the alimentary mucous membrane, presents at least a degree of particularity, by determining, with some precision, the whole number of the *Gastro-enteric Follicles* of the human body, or Follicles of Lieberkühn, *and how they are in every instance formed by meshes of veins;* while the arteries enter only inconsiderably into the composition of the same mucous membrane, to an amount in some measure comparable to the presence of the arteries in other erectile tissues, as the corpus spongiosum and cavernosum penis. In the latter, it is familiar to every practiced anatomist, that the branches of the arteries are but small, as they terminate in the cells of the penis, which are to be considered as only a modification of the incipient stage of venous trunks. If the corpus spongiosum were in fact spread out into a thin and single membrane, so as to line a hollow viscus, it would present no very undue representation of what I have denominated the *superficial venous layer* of the alimentary canal; it being also admitted that, within the circuit of every anastomosis, a follicle was formed.

Viewed on the preparations of the mucous membrane of the small and large intestines which I have, these follicles appear like puncta lachrymalia disseminated by thousands over every inch square, and existing so invariably upon every part, that, as I have stated, the smallest calculation of their numbers puts them at from forty to fifty millions.

It may be stated incidentally, that it is the whole of this vascular and follicular structure, endowed with vital actions the most important to life, and presenting in the aggregate an area of about thirteen square feet (the size of a small breakfast table), whose morbid derangements constitute the essential features of Asiatic cholera.[1] It has been shown, in some of my dissections, that this apparatus, in the progress of cholera, is detached entirely from the stomach and colon, in consequence of the excessive actions going on in them. The small intestines also, in some of my preparations, exhibit in patches a similar phenomenon; but, as the entire observation has been presented to me in its true light only since the disappearance of the disease, I have had no means of ascertaining the extent to which they suffer in this way.

The anatomy of the muciparous system of the alimentary canal unquestionably requires a more exact attention than is generally bestowed upon it, and especially so as to distinguish between the other glandular apparatus, and the foramina or follicles now under consideration. The following extract will explain the difficulty which exists with some in regard to a proper conception of the latter:—

"The mucous glands, called also follicles or cryptæ mucosæ, are to the membranes of that name what the sebaceous follicles are to the skin; that is to say, folds of the mucous membrane in form of a *cul-de-sac*, whose orifices open upon that membrane. These *follicles have*

[1] For illustrative preparations by the author, see Wistar Museum.

not yet been discovered over the whole surface of the mucous membrane; but here, as with the skin, analogy leads us to admit them. It is not long since they have been discovered in the pituitary membrane, where their existence had been denied. Be this as it may, we shall use the same observation upon these glands that was made on the sebaceous, viz., the impossibility of making an exact dissection of the capillary tissues does not allow us to discover all the forms of animal matter; but wherever a particular humor is found in a tissue, we are forced to conclude that this latter is organized in such a manner as to be able to produce it, and when in place of one humor we meet with many, we must acknowledge that the tissue is complex. Such is precisely the case with the mucous membrane of the digestive canal, and especially of the stomach, which could have a form of animal matter calculated to furnish digestive juices, although no gland destined to that purpose is discoverable."[1]

In infancy, especially, the mucous glands have a sensible thickness, which enables us to see them, but the smallest of them require the aid of a microscope, and appear to have been described by Galeati.[2] As the paper is not to be had in any of the public libraries of this city, I can only quote from it on the current authority of anatomical works. In a note to the anatomy of the human body by Sir Charles Bell, article Intestine, it is stated as follows: "It has been supposed that the fluids excreted from the surface of the intestines were furnished by very minute foramina (which are visible by particular preparations) in the interstices of the villi. See the letter of Malpighi to the Royal Society of London on the pores of the stomach, and the paper by M. Galeati in the Bologna Transactions, on the inner coat, which he calls the cribriform coat. The pores, according to Galeati, are visible through the whole tract of the canal, and particularly in the great intestines." Meckel designates these as glandular bodies under the name of *glandulæ mucosæ, cryptæ minimæ.* Another order of glands are those of Brunner.[3] They are readily found in the duodenum at all ages; and particularly well in infancy, as low down as the ileo-colic valve. The third order are the glands of Peyer, discovered in 1677.[4] The celebrated Ruysch appears also to have understood the existence of the follicles of the stomach, and Swammerdam to have had some idea of those of the small intestines,[5] and he calls them tubuli glandulosi intestinorum interiores.

Mascagni has also introduced views of a good kind in regard to the follicular structure of the stomach and colon.[6] But it is to Sir Everard Home that we are indebted for one of the best papers on the glandular structure of the stomach of different animals.[7]

As the real muciparous glands have an orifice leading into each, by

[1] Broussais' Physiology, first American edition, p. 419.

[2] *De cornea ventriculi et intestinorum tunica.* Comm. Bonon. 1745.

[3] *Glandulæ intestini duodeni vel pancreas secondarius;* discovered in 1715. See Mangetus, Theat. Anat.

[4] See also Mangetus for the description from Peyer.

[5] Mangetus, Theat. Anat. vol. i p. 310.

[6] *Prodromo della grande anatomia.* Tab. xiii.

[7] Phil. Trans. 1807 and 1817; and also Comparative Anatomy.

the admission of anatomists, the follicles described commonly by them are of this description, and are not comparable in number to the follicles found in the venous meshes. The highest estimate of the number of the former, as made by M. Lelut, fixes them at about forty-two thousand.[1] In consulting many of the distinguished modern authorities on this subject, there seems to be scarcely anything in the anatomy of the intestinal canal which was presented till lately in a more indefinite way (especially in regard to the small intestines) than the difference between the follicles, properly speaking, and the glands; and none of them, so far as I know, had, previously to myself, undertaken to approximate the entire number of the follicles, and to point out how each one is the centre of a venous anastomosis, is formed by it, and always exhibits itself in a collapsed state when the vein is not turgid.[2]

SECT. IV.—HISTOLOGY OF MUCOUS MEMBRANES.

The extent of the mucous coat of the alimentary canal, and the important and varied sympathies which it has with most other parts of the body, render proper some remarks on membranes of this kind, generally. Mucous Membranes are so called from the nature of the secretion which they furnish: and the term having been first applied to the lining coat of the nose, a similitude of character has caused its extension to that of other organs. The celebrated Bichat, the founder of the science of general anatomy, was the first to adopt fully, and to perceive the value of, this classification; since which it has been almost universally received by anatomists.

As the skin forms an external covering to the body, so mucous membrane lines the internal surface of the hollow viscera. When it is recollected that this membrane forms an internal tegument to the whole alimentary canal, from the mouth to the anus; to all the urinary and genital apparatus; to the whole respiratory system, from the nose down the trachea and throughout the lungs; it will be admitted that its extension exceeds much that of the skin.

A mucous membrane presents two surfaces, one of which adheres to the contiguous parts, and the other is free by being internal. The adherent surface is attached by a cellular structure somewhat condensed. This cellular structure is principally remarkable for its want

[1] Bouillaud, Traité du Choléra, p. 256.

[2] The anatomy of the Gastro-intestinal mucous membrane has elicited several good papers in Europe since 1835, inclusive, the period of my own publication, which was in anticipation of the others. In point of date they are rather confirmatory of preceding observations than distinguished by novelties, and the venous anastomosis does not seem to be understood or appreciated, except by Dr. Gaddi, of Modena, alluded to in a preceding note. In addition to the authorities already quoted, the reader may advantageously consult Boehm de Gland. Intest. Struct. Penit.; Berol. 1835. Boyd on the Structure of the Mucous Membrane of the Stomach, Edinburgh Med. and Surg. Journal, 1836. Likewise, Recherches Anatomiques sur la Membrane Muqueuse, &c., par M. Natalis Guillot, in L'Expérience, p. 161, Paris, 1837–8; and Müller's Archives, 1838 and 1839. The extreme difficulty of introducing American books into Europe, owing to high duties, and a very general ignorance, even among scientific men, of our proceedings, place an American author in a very disadvantageous position. The Germans exhibit a vigilance on this subject much more active than their French and English neighbors.

of disposition to secrete fat into its interstices; a property of immense importance, as without it obstructions would be continually occurring to the destruction of life: it is pervaded by a multitude of fine vessels and nerves, running forward to be spent upon the mucous membrane; and has been unfortunately named *nervous coat*, by anatomists of high authority. The strength of attachment which it furnishes is somewhat varied; for example, in the small intestinal canal I have often seen the mucous membrane caught at one end and entirely withdrawn from the muscular coat, an experiment which alone can give rigid ideas of its greater length, as by it all the duplicatures or valvulæ conniventes are stretched out. The experiment succeeds much more certainly, by the regular pressure of a column of water between the tunics of the intestine. The mucous membrane of most organs is arranged into wrinkles and duplicatures, for the purpose of augmenting its extent. This arrangement prevails in the nose, and, as mentioned, in the œsophagus, in the stomach, and intestines; to say nothing of many other instances which are noticed in the description of each organ. In some examples, they are permanent, and, in others, depend on the state of contraction of an exterior muscular coat. The interior face of the mucous membranes, allowance being made for the inequalities just stated, moreover, presents, when closely viewed, an abundance of more minute depressions and of elevations, causing it to resemble velvet. Some of these depressions are so large as to give it a cellular appearance,[1] as in many parts of the intestinal canal, and in the gall-bladder, and have been particularly described by Sir Everard Home.

Each mucous membrane is laid down upon an extremely delicate substratum of basement membrane, the best mode of discovering which is to take a portion of the stomach from near the pyloric orifice, which has been kept for several months in alcohol, the latter having in that state gradually lost its strength. Then, by scratching off the mucous membrane with the thumb nail, the basement membrane will be turned up along with it. In this condition it is seen as a thin, transparent, structureless or amorphous layer.

In regard to organization, the mucous membranes are of a soft, spongy consistence; easily yield to mechanical violence; and depend for their strength upon the surrounding cellular coat. They are not of a uniform thickness; for example, they are much thinner in the urinary and genital apparatus than in the alimentary canal; they also present some varieties of consistence. They yield very readily to putrefaction, and are quickly reduced to a pulpy state by the action of the mineral acids. Caustics of all kinds act more promptly on them than on the skin, owing to the protection of the latter by a dry, thick epidermis. Bichat states that, in the practice of the Hotel Dieu, this effect was frequently exemplified by the administration of lunar caustic among the common people for the purpose of poisoning. The nitric acid, leaving the silver, quickly applies itself to the mucous membrane of the stomach, and, disorganizing it, forms a whitish

[1] They are not to be confounded with the follicles, but are a miniature representation of what is called tripe, in culinary language.

eschar, which, if life be preserved long enough, is finally detached in a membranous form.

One of the remarkable properties of the mucous surfaces of the stomach and intestines is that of coagulating milk. According to the experiments of Spallanzani, the gastric juice, in the living state, assists in this change; but it is perfectly well known, in domestic affairs, that the dried stomach of a calf is also productive of it. The observations of the same author led him to conclude that the peritoneal and the muscular tunics of the stomach are insufficient to produce this effect.

The internal surface of the mucous membranes is furnished with small projecting points or spiculæ, called papillæ or villi (see Fig. 172). They are particularly conspicuous and numerous, as mentioned, on the upper surface of the tongue and in the small intestine, and bear an analogy of function and organization with the very fine papillæ which are seen invariably on the surface of the cutis vera. These papillæ are constantly furnished with nervous filaments, giving them a high degree of sensibility and with an abundance of blood-vessels. The term papillæ has been more exclusively applied to the projections on the surface of the tongue, from their greater size: they are there also more distinctly covered with an epidermis, frequently called epithelium, or periglottis. The villi, from their connection with the process of digestion, have been emphatically denominated the roots of animals.

It should be observed that, notwithstanding the assertion of Leeuwenhoek, Hewson, Hunter, and others, the fact is still called in question by many of the most distinguished anatomists, MM. Béclard, J. F. Meckel, Rudolphi, Müller, &c., whether the orifices of the lacteals are, under any circumstances, open on the surface of the villi. Admitting that they do not open as stated, the power of interstitial absorption in the mucous membrane will still account for the chyle finally getting into the lacteals; as well as for fluids passing into the circulation from the stomach, when its continuity with the intestinal canal has been interrupted.[1]

The Epidermis or Epithelium of mucous membranes is very distinct at their external orifices, but becomes less and less apparent towards the interior of the body, until it finally cannot be distinguished by the eye alone; and anatomists of a former period generally considered that it is entirely deficient, notwithstanding the assertion of Haller to the contrary. It is a matter of common observation that, when the interior of mucous membranes is exposed, by an eversion for a long time, to the action of the atmosphere, they take on more of the structure of skin and become evidently covered with a cuticle which protects them and diminishes their secretion. This is exemplified in eversion of the vagina from prolapsed uterus; in elongated and tumid labia interna and in other ways. Restore the parts to their natural situation, and they are brought back to their original structure. In the partial prolapse of the mucous membrane of the rectum, from piles, corresponding circumstances occur. From this we infer that the full development of cuticle depends very much upon the degree of exposure which any surface of

[1] Should the suggestion of the absorbing powers of the gastro-enteric follicles which I have proposed in Section III. be correct, it will dispose of the difficulties and opposing opinions alluded to in this paragraph.

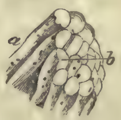
body has to undergo. The reverse also takes place: shut up or close any surface of the skin so that it is put in the condition of an interior cavity, and it immediately begins to assimilate itself to a mucous membrane. This is proved by the tendency in young children to a detachment of the cuticle, or excoriation of the opposed surfaces of the deep wrinkles about their thighs and in their perineum; a tendency obviated by the nursery practice of covering these surfaces with powdered starch. It is also manifested frequently in the dressing of wounds with sticking plaster, where an incautious approximation of the contiguous surfaces of the skin not only is followed by excoriation, but even by ulceration. The existence of an epithelium everywhere on mucous membranes is, however, now definitely settled by microscopical observers, and has become one of the most established points of anatomy. This epithelium is formed by a continuous layer of cells not only in the gastro-intestinal mucous membrane, but in the various prolongations of the latter into the ducts of the proximate glands; and in fact a similar arrangement exists wherever a mucous membrane is found. These cells are, according to many, the emanation of an amorphous basement membrane; they execute the specific secretion of the part which they cover, and thus whatever may be the similitude of their structure, perform very varied offices.

Fig. 175.

Fig. 176.

Fig. 177.

Fig. 178.



Varieties of Cells or Corpuscles forming the Epithelium of Mucous Surface.

Fig. 175.—*a*, *b*, *c*, *d*, *e*, *f*. Nucleated ciliary cells; their free end straight, and furnished with filaments, called cilia, of different shapes. *a′*. Nucleus. *d′*. Cilia.

Fig. 176.—A row of ciliated cells, rounded at the end. *a*. Nuclei. *b*. Cilia.

Fig. 177.—Cylindrical cells apart, with their nuclei.

Fig. 178.—Cylindrical cells grouped compactly. *a*. Bodies. *b*. Free extremities.

The mucous membranes vary in color from a very light pink to a deep red, which is owing to the blood that circulates in them. In cases of suffocation, they become almost brown from the congestion of blood in them, while in fainting they turn white from the desertion of the latter. The vessels, after having penetrated the thickness of the membrane, ramify with extreme minuteness on its surface. The veins in an injection invariably predominate over the arteries by their greater size and distensibility. In consequence of their superficial situation, the vessels being unsupported on one side, are exposed to rupture from slight concussions; in this way hemorrhage is produced in the lungs from coughing; and bleeding at the nose from blows on the head.

Exhalant orifices exist in great numbers in the mucous membranes; this is especially the case in the lungs, where the pulmonary perspiration, as it is called, is very obvious to common observation. Elsewhere, this discharge is so much blended with the mucus of the part that it is difficult to appreciate its quantity. From the superficial situation of the blood-vessels, it is clear that the exhalant orifices or pores have but a short course to run. This is considered by Bichat as a satisfactory reason for the tendency of the blood to escape through them, or to ooze out where there is no rupture.

Absorbents exist also in great numbers, as proved by the absorption of chyle, of watery drinks from the intestinal canal, and by the inhalation of the vapor of spirits of turpentine into the lungs, rapidly communicating the particular smell of this article to the urine. There are, moreover, cases recorded of obstructed urethra, where the urine has been almost entirely absorbed by the mucous coat of the bladder.

In regard to nerves, the mucous membranes are well furnished with them. Bichat has remarked that, wherever these membranes are situated near the surface of the body and enjoy common sensibility, they are almost wholly furnished from the central portions of the nervous system, as the brain and spinal marrow: this is exemplified in the conjunctiva, the pituitary membrane, the palate, the glans penis, &c. On the contrary, the sympathetic nerve furnishes the intestines, the bladder, and the excretory tubes generally.

Mucous Glands, as they are called, exist throughout the system of mucous membranes, being situated either under them or in their thickness. From them is derived the mucilaginous fluid which lubricates abundantly their interior surfaces, so as to facilitate the passage of extraneous bodies, and, at the same time, to protect the membrane from mechanical violence. These glands are of various sizes, from that of the tonsils and the muciparous glands on the root of the tongue to the almost imperceptible cryptæ of the bladder and urethra. Their shape is either lenticular, rounded, or that of a crypt or pouch. The former two have their parietes of a sensible thickness, but the last are too thin to be distinguished from the mucous membrane itself. For the most part, the excretory duct of these glands is short and patulous, so as to lead directly into the substance of the gland. This is remarkably the case with the tonsils, which consist in a congeries of these follicles, and with the glands on the root of the tongue. In some animals they are so numerous as to form almost a distinct lamina to the intestines; after the manner of the human subject, on the palate and parietes of the mouth.

The Mucosity discharged from these glands is one of the principles of animals, and, as is well known, exists also to a great extent in some vegetables. When perfectly pure and fluid, it is white, transparent, inodorous, and insipid. It is insoluble in alcohol, but soluble in acids. Water forms more than nine-tenths of it; the remainder is mucus, properly speaking, blended with some neutral salts of soda and potash.

The mucus which covers the surface of the mucous membranes consists chiefly of separated particles of epithelium mixed with a fluid exudation, while the mucous follicles are said to pour out a fluid holding mucous globules suspended.

The mucous membranes are exposed to a multitude of morbid alterations, such as polypus, scirrhus, cancer, phlegmorrhagiæ or serous fluxes, blennorrhagiæ or mucous fluxes, inflammation in all its forms, gangrene, ulcerations, and congestions.

CHAPTER V.

OF THE ASSISTANT CHYLOPOIETIC VISCERA.

SEC. I.—OF THE LIVER.

THE Liver (*Hepar*, *Jecur*) secretes the Bile, and is the largest glandular body in the human frame. It, as mentioned, occupies the whole of the right hypochondriac region, the upper half of the epigastric, and, as it becomes thinner in going towards the left side, it occupies a small space in the right superior part of the left hypochondriac region. Its whole superior face is in contact with the diaphragm; on the left it is bounded by the spleen, and below by the stomach, and the transverse colon; behind it, are the vertebral column and the ascending cava.

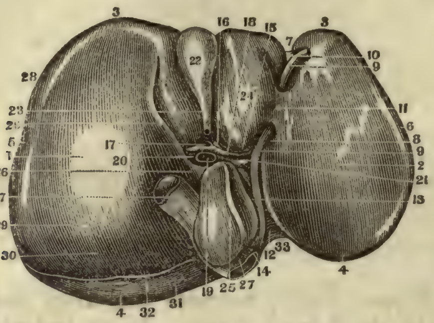
The shape of the liver is like one-half of an ovoidal body cut into two in the direction of its long diameter, and having the thick end turned to the right side. It is about ten inches in length by six or seven wide, and weighs from four to five pounds in the adult. Its color is a reddish brown, generally; though, on its under surface and about its edges, broad blue or black patches are constantly met with, which do not indicate any morbid derangement.

Its upper surface is of a uniform convexity, rather more prominent at the right posterior part than elsewhere; adjusts itself accurately into the concavity made by the under surface of the diaphragm, and is unequally divided from before backwards by the suspensory ligament. The anterior margin is thin, and is notched where the suspensory ligament begins; the posterior margin is much thicker, and has near its middle a broad depression, to fit it to the projection of the vertebral column. The ascending vena cava forms a superficial sulcus upon this margin, and frequently there is a complete canal through the substance of the liver for transmitting it. The right extremity is very thick, and almost fills the hypochondriac region of that side, while the left extremity is reduced to a thin, tapering, and flexible edge.

The under surface of the liver is much more irregular than the upper; it is traversed in an antero-posterior direction, in a line corresponding with the attachment above of the suspensory ligament, by the umbilical fissure (*sulcus umbilicalis*), which extends from the notch in the front edge to the depression behind, and obtains its name from having accommodated in the fœtal state the umbilical vein, now converted into a round ligamentous cord. In the posterior part of this fissure is likewise to be seen, in the same condition, what remains of the ductus

venosus. The anterior portion of the umbilical fissure is not unfrequently converted into a complete canal, by a portion of hepatic substance crossing it like a small bridge. The transverse fissure (*sulcus trans-*

Fig. 179.



The Inferior or Concave Surface of the Liver, showing its Subdivisions into Lobes.—1. Centre of the right lobe. 2. Centre of the left lobe. 3. Its anterior and inferior, or thin margin. 4. Its posterior, thick, or diaphragmatic margin. 5. The right extremity. 6. The left extremity. 7. The notch on the anterior margin. 8. The umbilical or longitudinal fissure. 9. The round ligament or remains of the umbilical vein. 10. The portion of the suspensory ligament in connection with the round ligament. 11. Pons hepatitis, or band of liver across the umbilical fissure. 12. Posterior end of longitudinal fissure. 14. Attachment of the obliterated ductus venosus 13, to the ascending vena cava. 15. Transverse fissure. 16. Section of the hepatic duct. 17. Hepatic artery. 18. Its branches. 19. Vena portarum. 20, 21. Its sinus, or division into right and left branches. 22. Gall-bladder. 23. Its neck. 24. Lobulus quartus. 25. Lobulus Spigelii. 26. Lobulus caudatus. 27. Inferior vena cava. 28. Surface of liver to fit the ascending colon. 29, 30. Surface over the right kidney and the right renal capsule. 31. Portion of liver not covered by the peritoneum. 32. Inferior edge of the coronary ligament of the liver. 33. Depression made by the vertebral column.

versus, intermedius) is situated in the middle of the under surface of the liver, and extends along a third or fourth of the long diameter of the latter. It begins somewhat to the left of the umbilical fissure, and crossing it at right angles, proceeds towards the right extremity. It contains the vena portarum, the hepatic artery, and the hepatic duct, lymphatics, and nerves; all of which are bound to each other by a close cellular substance.

The suspensory ligament above, and the umbilical fissure below, give occasion to divide the liver into Lobes, Right and Left; of which the right is by much the larger, and accommodates almost entirely the transverse fissure, having also on its under surface some subordinate elevations, to wit, the Lobulus Spigelii and the Lobulus Quartus, together with the Gall-Bladder.

The Lobulus Spigelii is placed between the transverse fissure and the posterior margin of the liver, to the right of the posterior end of the umbilical fissure. Its shape is somewhat prismatic, bifurcating in front; one of the elongations or prongs is a papilla overhanging the transverse fissure, and is, therefore, considered as one side of the gateway (*porta*) opened for the vena portarum; the other elongation is a small ridge, sometimes called Lobulus Caudatus, and is lost gradually on the under surface of the great lobe, by inclining to the right.

The Lobulus Quartus, or Anonymus, is not by any means so elevated as the Spigelii, but having a flattened surface, is placed in front of the transverse fissure, between the fore end of the umbilical fissure and the gall-bladder; its posterior extremity is the other side of the gate-

way (*porta*) of the Liver, and is just opposite to that furnished by the Lobulus Spigelii.

Ligaments.—The liver, from being so fully enveloped in peritoneum, has a smooth glossy appearance. The reflections of this membrane, from it to the parietes of the abdomen, form the ligaments, as they are called, which consist each of two laminæ. The Falciform Ligament, or Suspensory, contains in its lower margin the remains of the umbilical vein, now called Ligamentum Teres. It begins at the umbilicus, extends from it along the linea alba and the middle line of the diaphragm, and, as mentioned, is reflected to the upper surface of the liver, from the anterior to the posterior margin. The Right Lateral Ligament is situated behind, and departs from the back part of the diaphragm to the posterior margin of the right lobe. The Left Lateral Ligament also goes from the back part of the diaphragm, and is attached along the posterior margin of the left lobe. Where the suspensory ligament inclines on each side into the lateral, it passes with so much obliquity as to leave some portion of the posterior margin of the liver uncovered by peritoneum; the latter, where it describes the periphery of this space, has been rather unnecessarily designated as the Coronary Ligament.

In addition to the peritoneal coat, the liver has another, connecting it with the peritoneum, and seeming to be only condensed areolar substance, which also penetrates into the substance of the gland, and holds its constituent parts together. It is particularly well seen within the circle of the coronary ligament.

Of the Organization of the Liver.

The glandular substance of the Liver is fragile and easily lacerated. It consists of a congeries of minute spheroidal or polyhedrical grains, called by Malpighi *acini* from their resemblance to small berries. They are clustered into small lobules and are best seen on tearing the organ. These lobules are united in mass by the elongations of the cellular coat, intermixed with a white and a yellow ligamentous tissue, and are traversed by the trunks of the blood-vessels. Each of these grains is about the size of a millet seed, and is a representative of the entire gland, as its structure is complete in itself; being formed by the capillary terminations of the blood-vessels, and by the corresponding origins of the hepatic duct, called the pori biliarii.

The liver is made extremely vascular by the ramifications of three kinds of blood-vessels, the Vena Portarum, the Hepatic Artery, and the Hepatic Veins. The first two convey the blood to it, and the third removes it again, into the general circulation, by emptying into the ascending vena cava. There are also the biliary tubules (*pori biliarii*) or the commencing radicles of the Hepatic duct, the Lymphatic vessels, and the Nerves.

When examined with a microscope, the acini present under particular circumstances two colors, a brown and a yellow. This difference of color, observed originally by Ferrein,[1] gave occasion to the divi-

[1] Mém. de Paris, 1735, Hist. 51.

sion of the substance of each acinus into Cortical (*substantia corticalis, brunnea*) and into Medullary (*substantia medullaris, flava*), the propriety of which is, however, not fully sanctioned, even at the present day. The Cortical or brown matter is the investment of the other, and depends for its color principally upon the great proportion of capillary vessels, derived from the three orders, the vena portarum, arteria hepatica, and venæ hepaticæ. The Medullary or yellow matter is the place of origin of the biliary ducts, and is supposed to derive its color from the presence of bile in their radicles.[1] The ground of this distinction is so unsatisfactory, and it seems to depend so much upon some contingent condition of the circulation of the blood, that while it is admitted by very eminent authority, as Bichat and J. F. Meckel, it is as earnestly rejected by equally high, as Portal and E. H. Weber. My own observations have been such as to incline me to the authority of the two latter.

Some new microscopic details have been attached to the account of the liver within a few years, by Purkinjé and Henlé, and are fully confirmed by Wagner and others.

The proper hepatic structure, the parenchyma of the liver, it would thus seem, has, in the case of each acinus, its collection of very fine tubes (*penicilli* and *pori biliarii*) lined with epithelial cells, which are so near together as to have their shape moulded by mutual contact, and to become polyhedrical. The cells are about the 1-7000th of a line in diameter, and have a nucleus of about the fourth or fifth of that size.[2]

These cells have their shape varied from a flattened spheroidal to a quadrangular or pentangular one, and contain within them a yellow bilious-looking material, having intermixed with it several globules of fat large and small. The biliary matter contained in them is concluded to be proof sufficient of these cells being the real agents of the secretion of bile. The essential features of the latter process consist in the successive evolution of these cells, of their active elaboration of the bile—of their rupture or dehiscence, and of the further conveyance of the bile into the pori biliarii. The existence of these hepatic cells is easily ascertained: by tearing a liver, especially a young one, and then scraping it, they turn out so abundantly that, allowance made for the blood-vessels, and cellular or areolar tissue, they seem to compose it almost wholly.

The idea of Huschke in regard to their connection with the pori biliarii is, that the bile is elaborated in their central nucleus, as proved by nitric acid, and that an extremely attenuated branch of a bile duct 1–684th of a line in diameter, reaches each cell, being attached to it like a pedicle, and in that way receives the discharge of bile. He believes that the fat of the hepatic cell or vesicle is converted into bile. This view of the terminal points of the biliary ducts is very much a repetition of the penicillous structure of former anatomists, its arrangement

[1] The application of these terms has been changed since their first use, as Ferrein called the brown matter the Medullary, and the yellow the Cortical.

[2] Hallman has placed these structures at a much smaller size, about one-tenth of the diameters stated: and Wagner makes them much larger, amounting in fact to 1–100th of a line. There are other measurements of an intermediate kind, showing all together that there are great diversities in their real magnitude.—*Huschke, Traité de Splanchnologie*, p. 123.

being perhaps more attenuated than any they had an idea of. He says that, to the present moment, he has never witnessed the reticulated connection of the fine extremities of the bile ducts in their origin from the acini, which are represented in the ideal figure of Mr. Kiernan. Also that he has not found the anastomoses of the larger bile ducts, said to have been discovered by the latter, in the left hepatic ligament; and that he has been equally unsuccessful in detecting the communications said by Berres to be between the blood-vessels and the biliary ducts.

The several branches of the *Hepatic Duct* take their origin then in the acini. The primordial, or most minute ones (*penicilli*) converge several of them to the same point, giving a penicillous or brush-like appearance, while the larger (*pori biliarii*) branches converge into their respective trunks successively or in pairs. These several tubes constitute the biliary canaliculi (Pori Biliarii in the common language of anatomy), and are always in the same group with the branches of the Vena Portarum and Hepatic Artery. It is unsettled whether the brush-like or penicillous ends of the pori biliarii are enlarged at their free extremities so as to be there like a pin at its head, in a manner so common in glandular structure. Krause asserts the fact, and states that the enlargement measures from $\frac{1}{42}$d to $\frac{1}{37}$th of an English line, and there are said to be preparations of the kind in Utrecht.[1] In the practice of Professor Geddings, of South Carolina, a case of obstruction of the hepatic duct by a medullary mass, in arresting the bile, produced a distension of the extreme biliary canaliculi, which were observed by him to commence in cœca closely impacted one against another.[2]

The most minute branches of the biliary ducts[3] in the acini are so close together that they seem to be united to one another, and are considered by Mr. Kiernan to form absolutely a plexus. It is asserted that a fine injection passes more readily from them into the lymphatics than into any other order of vessels; which may account for the promptitude of jaundice upon an obstruction of the hepatic duct.

The Hepatic Artery is a branch of the cœliac, and in approaching the transverse fissure divides into three or more branches, that penetrate the substance of the liver, between the sinus venæ portarum and the ducts as they come out; one branch goes to the right lobe, another to the left, and a third to the lobulus Spigelii. There is some variety in regard to the precise mode of distribution, and their division into subordinate ramifications frequently occurs, before they get fairly into the substance of the liver. When there, they seem to be intended for the nourishment of this organ, and follow the ramifications of the vena portarum and of the biliary ducts, forming upon them a very delicate and complicated tissue of anastomosing vessels, which communicate with the vena portarum.

The hepatic artery, having been reduced into extremely fine branches, is found expending itself upon the walls of the vena portarum and of the biliary ducts; it must, of course, supply itself with nourishing

[1] Müller, Phys. p. 491, London, 1840.

[2] North Am. Journ. 1835.

[3] Their diameter, according to Müller, varies from $\frac{1}{78}$th to $\frac{1}{55}$th of an English inch; they are therefore much larger than the finest capillary blood-vessels; this would seem to be an excessive estimate.

blood, and also the parenchyma of the liver; and it finally makes a plexus in the case of each acinus intimately blended with the ultimate plexus of the vena portarum, with which it has a free communication as readily proved by injection. There ought to be but little doubt that the vena portarum is the primary recipient of its blood. The analogy is established in the gall-bladder, where the cystic artery discharges into the cystic vein: the latter, then proceeding to the vena portarum, is sufficient proof of the compatibility of this arrangement. The venous vasa vasorum of the vena portarum is also in favor of it. But whether such termination is exclusively in the vena portarum may give rise to a question.

Many of the finer branches of this artery (*rami serosi*) reach from the interior to the surface of the liver, and, running out a great length with almost uniform size, make, under the peritoneal coat, a most beautiful and exquisite reticulation by their own branches, and those of adjoining vessels of the same kind. A reticulation so fine that it strongly resembles a lymphatic one.

The Vena Portarum, having arisen from the junction of all the veins of the stomach, intestines, pancreas, and spleen, is about three inches in length when it reaches the transverse fissure of the liver, by going over the duodenum and under the pancreas. It immediately divides into two branches, called collectively the Sinus Venæ Portarum, which is at right angles with the trunk of the vein. The right branch, being the shortest and largest, is distributed by radiating trunks to the right lobe of the liver; the left branch is distributed, after the same manner, to the left lobe, to the lobulus Spigelii, and to the lobulus quartus. These routes of the vena portarum are sometimes called portal canals.

The vena portarum is finally reduced into extremely attenuated capillary extremities, whose diameter is from $\frac{1}{250}$th to $\frac{1}{150}$th of a line in diameter according to Weber. They invest the acini, penetrate them to some extent, and anastomose freely together in observing this arrangement. Their meshes are occupied according to Weber almost wholly by the biliary canaliculi, but just doubts are now entertained whether they do more than come in contact with them, contrary to an opinion formerly held that they discharge into or anastomose with them. Their final termination is in the corresponding branches of the Hepatic veins, the freedom of which communication there is no difficulty in proving by injection as well as by the ordinary laws of the circulation of the blood.

The Hepatic Veins arise in the acini from the capillary terminations of the vena portarum and the hepatic artery. Their branches are successively accumulated into three large trunks, the collective area of which vastly exceeds that of the vessels bringing the blood to the liver. Two of these trunks come from the right lobe and one from the left, to empty into the ascending cava, while it is still in contact with the liver, immediately below the diaphragm. Just below the preceding trunks there are five or six, sometimes more, small hepatic veins, coming from the posterior margin of the liver, and from the lobulus Spi-

Fig. 180.

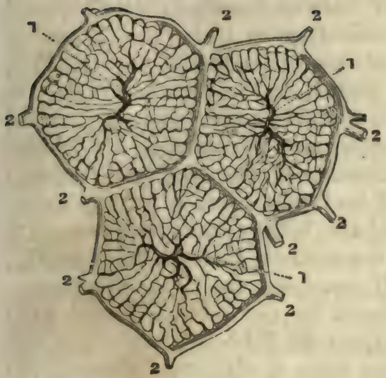


Fig. 181.

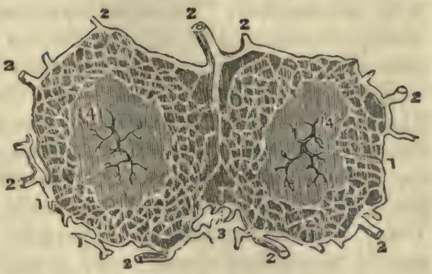


Fig. 180. Diagram showing the arrangement of the Blood-vessels within and between the Lobules (Kiernan).—2, 2. Interlobular branches of portal vein, forming the intralobular venous plexus, connecting the portal veins (2, 2) with the intralobular vein (1) in the centre, which is the commencing branch of the hepatic vein.

Fig. 181. 2, 2. Branches of the hepatic duct, which is supposed to commence in a plexus situated towards the circumference of the lobule, and called by Kiernan the biliary plexus. Within this is seen the central part of the lobule, containing branches of the intralobular (hepatic) vein (1).

gelii. The hepatic veins are destitute of valves, and remarkable for the thinness of their parietes. An injection passes readily from them into the other systems of vessels. They may be recognized by their insulated course, and by their consisting in trunks which converge from the periphery of the liver to the vena cava, while all the other vessels diverge from the transverse fissure to the periphery, and consequently the large branches cross those of the hepatic veins.

The larger branches of the venæ hepaticæ exhibit a remarkable number of very small branches with patulous mouths a sixth of a line or less in their diameter, which come directly from the contiguous acini; having arisen by still smaller extremities in connection with the capillary terminations of the other blood-vessels of the liver. The number of such foramina gives to the sides of the hepatic veins a cribriform appearance. The branches of the hepatic veins seem to free themselves more completely from their entanglement with the other vessels near the centre of the acinus, and then pursue a course by themselves not difficult to follow out.

Owing to the involution of one set of the hepatic capillaries with another, there is an essential and almost insurmountable difficulty in forming a conception of, or making a preparation which will elucidate, their ultimate arrangement. In explanation of this difficulty, Müller considers that there is an ulterior plexus of capillary blood-vessels with which the other three communicate freely; this is probably the fact, including the lymphatic system also; but the precise mode of its formation is as yet not ascertained, an idea long ago advanced by Chaussier in regard to all glandular structures.

According to the valuable observations of Mr. Kiernan,[1] the finer branches of the vena portarum, which he calls Interlobular veins, make

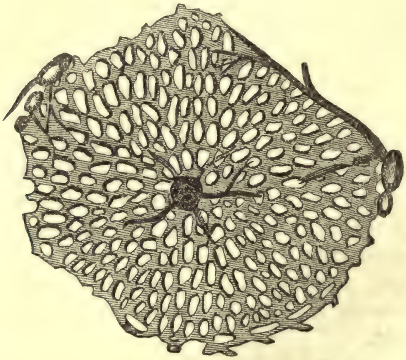
[1] Anat. and Physiol. of Liver, Phil. Trans. London, 1833.

a perfect and minute plexus surrounding the lobules or granular masses of the liver; they then form convergent lines of vessels directed towards the centre of each lobule, and communicating by transverse branches with one another. These latter connections, or the sets of veins making them, constitute the lobular venous plexus, and in their intervals are placed subordinate granules, or what he calls the acini. (See Fig. 180.)

He says, also, that the Hepatic Duct forms a plexus upon the lobules like that of the vena portarum; the plexuses of the contiguous lobules being indisposed to anastomose, though he thinks there is ground to believe in such anastomosis. The interlobular biliary ducts then penetrate the lobule and ramify by anastomotic connections through it. (See Fig. 181.) According, also, to Weber and Kroninberg, the incipient extremities of the biliary ducts make a net-work in the acini. Weber says that the diameter of these branches is from the 1-1340th to the 1-900th of an inch; that the blood capillaries have a diameter of from the 1-1959th to the 1-1463d of an inch; and that the distance passed by the blood from the smallest portal to the smallest hepatic vein is from the 1-80th to the 1-70th of an inch.[1]

The observations of Dr. Joseph Leidy, in a highly valuable paper on the anatomy of the liver,[2] show also that there are no terminal points to the pori biliarii in these lobules, but that they form, according to the idea of Mr. Kiernan, a reticulated intertexture, without cœcal appendages or spheriform enlargements of any kind.

Fig. 182.



Transverse section of an Acinus of the Human Liver, taken from a preparation by the author of this work; it is highly magnified, and presents to view the reticulated structure of the biliary tubes at their beginning. In the centre of the figure is seen the hepatic vein cut across, and several small branches terminating in it. Where the injecting matter did not run freely, it is seen standing in dots along the course of the vessels. At the periphery are seen branches of the hepatic artery, vena portarum, and hepatic duct.

The Hepatic Artery, Kiernan says, makes also a plexus upon the surface of the lobule, and penetrates interiorly from its periphery towards the centre, to end in the vena portarum. Meckel asserts that the branches of this plexus end in the incipient branches of the venæ hepaticæ.

The Hepatic Veins, according to Mr. Kiernan, are seen as a small

[1] Müller's Arch. 1844.

[2] See Researches into the Comparative Structure of the Liver, Art. 1 Am. Journ. Med. Sciences, for January, 1848, from which Fig. 182 is taken.

trunk in the centre of a lobule; this trunk, called by Mr. Kiernan the intralobular vein, arises from the convergence of from four to eight venules, from the periphery to the centre of the lobule.

It is stated by Mr. Kiernan that the elements of the above arrangement of ducts and blood-vessels are formed very distinctly in the left lateral ligament of the liver. Aberrant biliary ducts have been found also by Ferrein, in the left lateral ligament of the liver, in its isthmus crossing the ascending cava and that crossing the umbilical vein. They are attended by branches of the vena portæ, of the hepatic artery, and of the hepatic vein. The branches of the ducts are unattended with lobules and they anastomose. Mr. Kiernan in his experiments appears not to have succeeded in injecting the hepatic veins from the hepatic artery, though he can inject them from the vena portarum. His injection was probably not fine enough, as there is not the slightest difficulty in filling all the ducts and blood-vessels of the liver from either set, provided one throws in a very fluid injection; the use of water simply will prove this beyond doubt.

Mr. Kiernan's statements, it seems, have been adopted as decisive by his countrymen, both anatomists and physiologists, and by some of the continental anatomists. His great skill as a practical anatomist, and the protracted and ardent attention which he devoted to the subject, together with his characteristic reserve in advancing opinions upon a merely speculative basis, justly entitle his views to the great respect with which they have heretofore been received, though there may be some defects in them still to be supplied by other observations.

A greater reserve has been manifested by the German teachers: thus there is a remarkable discordance between his observations on the incipient state of the biliary pores, and Krause's and Huschke's; the latter speaks pointedly of the ideal figure of Kiernan. Wagner, of accomplished skill as an anatomist, in admitting that angular cells form the lobules (*acini*), and that these are separated, one from the other, by cellular substance, asserts "that he finds it much more difficult to say how the different vessels—the last divisions of the vena portæ, of the venæ hepaticæ, and of the ductus hepaticus—comport themselves in the interior of the lobules. I regard the beautiful figures and the descriptions of Mr. Kiernan as the best and most accurate that have been published, although they very certainly also include many mistakes."[1]

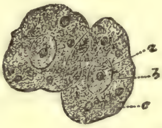
My own injections of the liver exhibit a very high vascularity upon the periphery and in the intervals of the acini; this vascularity falls off much in the substance itself of the acinus; and is then repeated in the centre of the acinus in originating the corresponding branch of the hepatic vein. These preparations are now of many years' standing. A similar exposition has been made by Dujardin and Verger,[2] who assert that the parenchyma of the lobules (acini) is absolutely without vessels and interior plexus, being made of oval gelatinous corpuscles, in the intervals of which the blood-corpuscles move.

The actual summary of the minute anatomy of the liver then is that a sub-acinus is formed by a reticulation of tubules, say pori biliarii,

[1] Elements of Physiol. London, 1842.
[2] Huschke, ut supr. p. 124.

made out of a basement membrane, transparent and amorphous. That these tubules have their interior surface paved or covered with multangular closed cells, which cells secrete the bile. That the reticulated pori biliarii discharge into simple cylindrical canals, biliary tubules they may be called, which occasionally anastomose; and the arborescent junction of which forms by successive union larger and larger trunks, until finally the solitary one called the hepatic duct is formed. The whole internal surface besides of the biliary canals is also to be con-

Fig. 183.



Secreting Cells of the Human Liver.—*a*. Nucleus. *b*. Nucleolus. *c*. Oil-particles.

Fig. 184.

Fig. 185.

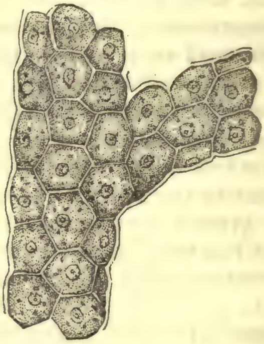


Fig. 184. A small portion of liver, being Fig. 182 more highly magnified. The secreting cells are seen within the tubes, and in the interspaces of the latter the fibrous tissue is represented. Leidy, loc. cit.

Fig. 185. Portion of a Biliary Tube, from a fresh Human Liver, very highly magnified. The secreting cells may be noticed to be polygonal from mutual pressure. Leidy, loc. cit.

sidered as covered with secreting cells, like those of the first pori biliarii, which arrangement represents the secretory apparatus of the liver. But to give activity to this apparatus, the blood-vessels are introduced; they penetrate into the structure of the acinus, and make in it a reticulated anastomosis of vessels. The branches of each set anastomose with their cognate branches, and the terminal branches of the several sets run into one another until the currents of blood are all inflected into the hepatic veins. The probability is, that the hepatic artery is first of all nutritious in distribution and function, and then discharging into the vena portarum, supplies, with it, the secreting cells of the liver; and that the blood, thus rendered completely effete, is passed into the hepatic veins to be returned into the general circulation.

The Lymphatics of the Liver are large, numerous, and deprived of valves; hence they can be readily injected, and make a brilliant close plexus on its surface, from which mercury soon subsides, owing to the freedom of their communication with the deeper lymphatics. They

leave it by various routes in large trunks, which ascend and depart by the several ligaments.

The nerves of the liver are branches of the solar plexus of the sympathetic, and reach it through the transverse fissure in company with the blood-vessels.

The liver appears in the embryo to be originally formed by a protrusion of the walls of a part of the intestinal canal.[1] The pancreas presents a similar mode of evolution. The lungs too, but of course from the trachea.

Of the Gall-Bladder.

The Gall-Bladder (*cystis fellea*) is a reservoir, for the bile secreted by the liver. It is fixed on the under surface of the great lobe, to the right of the umbilical fissure, and removed from the latter by the lobulus quartus.[2] It is an oblong pyriform sac, having its anterior extremity or fundus projecting somewhat beyond the anterior margin of the liver, while the posterior end reaches to the transverse fissure. Its long diameter inclines slightly to the right side, so that it is not precisely in an antero-posterior line. It varies in its shape in different subjects, being much more pyriform in some than in others. Its fundus is rounded and obtuse, while the posterior end is gradually reduced to a narrow neck, which is bent upon itself, so as to retard the flow of a fluid through it, and gives origin to the cystic duct. Its upper surface is in contact with the substance of the liver, and is received into a broad shallow fossa, while the lower surface is projecting, and by coming into contact with the transverse colon, tinges it with bile, by transudation after death.

The Gall-Bladder has three coats—a peritoneal, a cellular, and a mucous one.

The Peritoneal Coat is not complete, but only covers that part of the sac not received into the fossa on the under surface of the liver; it is, therefore, a continuation of the peritoneal coat of the latter; sometimes, however, the gall-bladder is so loosely attached to the liver that it almost hangs off from it, in which case the peritoneal coat is nearly complete.

The Second Coat is condensed cellular membrane (*tunica propria*). Through it ramifies a great number of lymphatics and blood-vessels; below, it attaches the peritoneal to the mucous coat, and above, the latter to the liver.

The Mucous Coat is always tinged of a deep green or yellow, by the bile which it contains percolating after death; for it is said to be, before that, of a light color. This coat is thrown into irregular tortuous folds or wrinkles of extreme delicacy, in the intervals of which are many round or polyhedrous cells, causing it to look, when floated in water, like a fine honey-comb: such as are about the fundus of the sac are superficial, and not so distinct; but those near its middle and

[1] Müller, loc. cit. p. 490.

[2] I have seen an instance where it was to the left of the umbilical fissure, on the small lobe. The latter was much longer than common. Dec. 1830.

about the neck are a line or a line and a half deep. In the neck or apex, and in the beginning of the cystic duct, are from three to seven, sometimes twelve semilunar duplicatures of the internal membrane, which also retard the flux and afflux of any fluid, though they do not afford so much resistance to the ingress as to the egress of it. These duplicatures are sometimes partially arranged into a spiral valve, projecting from the inside of the duct, and forming two or three turns.[1] Very small mucous follicles exist over the internal face of this membrane, the discharge from which fills the gall-bladder when the secretion of bile has been interrupted by diseased action, as in yellow fever, or by scirrhus of the liver. The mucous coat is also covered with its epithelial or secretory cells, like the hepatic ducts.

The artery of the gall-bladder is a branch of the hepatic. Its veins empty into the vena portarum. Its nerves come from the sympathetic, and its lymphatics join those of the liver.

The gall-bladder is developed as a diverticulum from the Hepatic Duct.

Of the Bile Ducts.

A succession of very fine branches (*biliary tubules*) having arisen from those in the acini of the liver, these biliary tubules are united into three or four trunks, by the time they reach the transverse fissure. These trunks there coalesce into a single Duct, the Hepatic, of eighteen or twenty lines in length, and about the diameter of a writing-quill. The Hepatic Duct is then joined at a very acute angle with that from the gall-bladder, the Cystic Duct which is somewhat shorter and smaller than it; the union of the two forms the Common Duct (*ductus communis choledochus*). The latter is larger than either of the others singly, and is three or three and a half inches long; it descends behind the right extremity of the pancreas through its substance, passes nearly an inch, obliquely, between the coats of the duodenum, becoming at the same time diminished in diameter, and, finally, ends by an orifice still more contracted, on the internal face of this gut, at its second turn, and about three or four inches from the stomach. The orifice is marked by a small surrounding tubercle somewhat obscured by the valvulæ conniventes.

The Hepatic, the Cystic, and the Common Duct are situated, as mentioned, along the right margin of the lesser omentum, and have the vena portarum and the hepatic artery to their left.

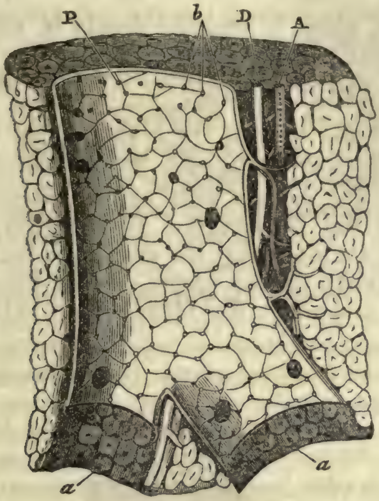
The bile ducts are formed by two coats; the external is a fibrous, lamellated, and very extensible membrane, while the internal is mucous, having the same structure with that of the gall-bladder, of which it is in direct continuation. The interior of the bile ducts, besides being paved everywhere with epithelial cells, is furnished with numerous glands for the secretion of mucus. Some of them, according to the observations of Theile, are ramified tubes which anastomose together; some resemble the Meibomian glands in their lateral cœca; others are an accumulation of small cells opening by a single orifice into the bile

[1] Discovered by M. Amussat, of Paris. He has also detected muscular fibres in the gall-bladder and biliary ducts, in which we see an analogy with other hollow viscera.—Am. Journ. Med. Sciences, vol. ii. p. 193.

duct. In the Cystic Duct, and at the lower part of the Common Duct, are several longitudinal folds. The Common Duct receives, just before it empties into the duodenum, the Pancreatic Duct.

Capsule of Glisson.—At the bottom of the transverse fissure of the liver is to be found a dense lamina, formed out of white and yellow elastic cellular fibrous tissue. It invests the vena portarum, the hepatic

Fig. 186.



Magnified section of a Portal Canal, or process of the capsule of Glisson, containing a branch of the Portal Vein, of the Hepatic Artery and of the Hepatic Duct.—P. Branch of vena portarum, *a*, *a*, a portal canal, formed amongst the lobules of the liver. The large orifices opening into the portal vein are the mouths of the larger branches. *b*. Orifices of interlobular veins arising at once from the portal branch. A. Hepatic artery. D. Hepatic duct.—(Kiernan.)

artery, and the biliary ducts; and, as they all keep together in their ramifications, this tissue follows them throughout the substance of the liver, and thereby forms sheaths for them, called by Mr. Kiernan portal canals. It may be considered as continuous with the processes sent in from the cellular coat; and, contrary to the opinion of Glisson, whose capsule it has been called, it is devoid of muscular structure.

Of the Bile.

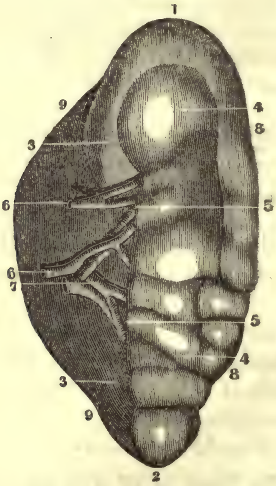
This secretion from the liver is of a deep yellow, sometimes green color: when recent, it is thin and fluid; but, after it has been conveyed to the gall-bladder, and permitted to remain there for some time, it becomes as thick as molasses, and increases also in the intensity of its color and in bitterness. Some anatomists have believed that there was a more direct communication between the liver and the gall-bladder than that through the hepatic and the cystic duct; but repeated and close observations have proved the opinion to be erroneous, or at least destitute of proper proof: it is therefore clear, that the difference between the hepatic and the cystic bile depends upon the watery particles being removed from the latter by the absorbing power of the internal coat of the gall-bladder.

According to Berzelius, the chemical analysis of bile furnishes about eighty parts of water, eight of a particular substance, Biline, which assumes a resinous condition on the application of an acid; three of mucus; and nine of saline matters; of which soda is a principal constituent.

SECT. II.—OF THE SPLEEN.

The Spleen (*lien*, *splen*) is situated deeply in the posterior part of the left hypochondriac region, and is bounded above by the diaphragm, below by the colon, and on the right by the great end of the stomach, and by the pancreas. It is not ascertained that it secretes anything. Its color varies from a deep blue to a dark brown. In shape it resembles the longitudinal section of an oval, being flat or very slightly concave on the surface next to the stomach, and convex on that contiguous to the diaphragm. Occasionally, its margins are notched; but this is not invariably the case. Its flat surface is slightly depressed longitudinally in the centre, into a fissure (*hilum liene*), which is imperfect, and where the blood-vessels enter into it by six or eight foramina.

Fig. 187.



Shows the Internal Face of the Spleen where it touches the Stomach.—1. Superior extremity. 2. Inferior extremity. 3. Posterior part of the concave face. 4. Anterior part of the same. 5. Fissure of the spleen. 6. Splenic artery. 7. Splenic vein. 8, 8. Anterior edge of the spleen. 9, 9. Its posterior edge.

Several spleens sometimes exist in the same individual, in which case the supernumerary ones are not larger than nutmegs. The common size of this organ is about four and a half inches long by two and a half or three wide, in which case it has a solid firm feel; but it very often exceeds these dimensions; its transition and varieties of magnitude are so frequent that no settled rule can be established. In its inordinate enlargements I have seen it only a little smaller than the liver; its texture in this case is soft, and easily lacerated.

Ligaments.—It is fixed in its place by three lines of reflection or processes of peritoneum, called ligaments, whose names indicate their places of attachment. They are the Gastro-Splenic Ligament or Omentum which passes from the stomach to the spleen, and in which are the vasa brevia of the stomach: the Splenico-Phrenic Ligament, which goes from the spleen to the diaphragm, attaching itself to the latter at the left of the œsophageal foramen, and then descending along the posterior internal face of the spleen, in a line, behind the gastro-splenic ligament: and the Splenico-Colic Ligament, which passes from the spleen to the colon, being, as it were, a process from the left extremity of the gastro-colic omentum.

The Peritoneum, by being continued over the spleen, gives it a complete coat, which is raised up with more difficulty than the corresponding membrane of any other viscus of the abdomen, and is commonly thrown into very small inequalities or wrinkles from the closeness of its adhesion to the internal coat and the want of a sub-serous cellular tissue.

The internal or proper coat (*tunica propria*) of the spleen is a grayish, compact, extensible, and elastic, ligamentous membrane, the use of which is evidently to sustain the natural shape of the organ, and to support its parenchymatous structure. It sends in processes to accompany the blood-vessels (*capsulæ Malpighii*), and from its internal face there proceeds a multitude of lamellæ and of fibres, which traverse its cavity in every direction, and reduce it into a cellular condition, not unlike the cavernous structure of the penis. This is called the trabecular tissue by Prof. Kölliker.[1]

Of the Intimate Structure of the Spleen.—The spleen, in proportion to its size, is furnished to a remarkable degree with blood. The largest branch of the cœliac artery runs to it along the superior margin of the pancreas, forming numerous serpentine flexures, and is distinguished for its thickness and size; it divides into several trunks before penetrating into the spleen, and enters by the foramina in the fissure. The veins come out by a number of trunks equal to what the artery is divided into; they assemble then into a single trunk, which attends the artery along the pancreas, is destitute of valves, and empties into the vena portarum.

The Splenic artery, having penetrated into this organ, is divided and subdivided into a radiating succession of very fine branches, which, according to the injections of Ruysch, do not anastomose with each other; in consequence of which one part is sometimes finely injected, and not another. This corresponds with my own observations. The veins, on the contrary, do anastomose, not only as regards the collateral branches of the same primitive trunk, but also by the collateral branches of different trunks. These anastomoses are not large. The veins of the spleen are remarkable for the tenuity of their coats, and for the great disproportion of their area with that of the arteries, it being in the larger trunks rated at five to one, and in the smaller at twenty to one. The larger veins look cribriform when viewed from their interior,

[1] See Cyclop. Anat. and Physiology.

owing to the number of fine branches which they receive. Krause states that the veins have numerous lateral dilatations, which communicate with their general plexus, or anastomotic connection.

The veins of the spleen, in their ramifications through this organ, besides their frequent anastomoses, undergo sinus-like enlargements, approaching the structure of the corpus cavernosum penis, and their walls are formed merely from the internal venous coat. The arteries terminate freely in the veins, as may be proved by fine injections, and by the microscope.

The mass of the spleen, even upon superficial examination, is seen to consist in a dark brown bloody pulp (*substantia rubra*), which is contained in the cells dividing the cavity of the internal coat, and may be easily demonstrated by tearing or cutting the spleen, and scraping it with a knife handle.

This pulpy substance of the spleen, under the microscope, is composed of small spheroid or oval granules of a reddish-brown color, and about the size of the globules of the blood. According to Mr. Gulliver,[1] they are more unequal in size than the blood-disks, their diameter varying from 1-6000th to 1-1777th of an inch. They are found in blood taken from the splenic vein, and they are easily separated from one another. Prof. Kölliker asserts that there are three distinct kinds of these splenic granules or cells, and also numerous free nuclei. These several elements of the pulp vary much in their proportions to one another. But a considerable part of the splenic pulp consists in blood-corpuscles in various stages of metamorphosis, until they become completely colorless, and in that state may be found in the blood of the splenic vein, vena portæ, and inferior cava.

The minute arteries of the spleen ramify in tufts among these granules, and then terminate in a plexus of venous canals, whose walls are so thin that the veins appear as mere channels in the pulp.

A question has arisen whether the pulp (*substantia rubra*) be extravasated into the cells of the trabecular tissue, or whether it be still retained in the extremities of the blood-vessels. Superficial examination is in favor of the first; but M. Marjolin denies it on the following grounds: that injections, cautiously made, pass immediately from the arteries into the veins, and that the spleen, when successfully injected and frozen, does not exhibit ice in the interstices of its vessels; while their capillary ramifications, distended by the injected fluid, are distinctly seen. From these facts he concludes that the glandular structure of the spleen is formed essentially of arterial and venous capillary vessels, with very delicate and extensible coats; that they communicate with one another without the intermedium of any cell; and that the extreme tenuity of these vessels, and their extensibility in every direction, are sufficient to explain the augmentation of volume of the spleen, under certain circumstances, as well as the promptitude of its diminution under others.

MM. Assolant and Meckel believe that blood, besides being in the arteries and veins, is placed in a state of particular combination and of intimate union with the other organic elements of this viscus, and with

[1] Gerber's Genl. Anat. p. 102.

a large quantity of albumen; and that this combination of the blood forms the dark brown pulp alluded to. The great quantity of albumen in the pulp is readily proved by the hard coagulum which it forms, when steeped in alcohol.

In addition to this pulp, many observers have met in the spleen with an abundance of rounded corpuscles (*corpuscula Malpighii*), varying in size from an almost imperceptible magnitude to a line or more in diameter.[1] They are of a gelatinous consistence, soft, grayish, and semi-transparent, and either cluster together, or are widely separated, and have a diameter generally of from one-sixth to a third of a line. Their exact structure is undetermined. By Malpighi, they were considered glandular, and by Ruysch[2] as convoluted vessels. Professor Sœmmering, from the following paragraph, seems to join in the opinion of the latter: "Qui nonnunquam occurrunt, acini vel glomeruli, microscopii ope accuratissime explorati, nihil sunt nisi vasorum fasciculi, vel teretes penicilli aut cirri vasculosi." According to the observations of Sir Everard Home, they swell considerably after an animal has finished drinking.

The corpuscles of Malpighi are at least vesicles, with very thin parietes; hence, when punctured, their fluid, which is found of an albuminous character, escapes, and they collapse. They are sometimes in a group of six, suspended to an arterial ramuscle like a pedicle. The vessels do not penetrate them, but are confined to their exterior, where they form a very fine net-work. The fluid which they contain is, according to Bischoff and Huschke, white, with a multitude of globules swimming in it, and looks very much like chyle. Huschke, after much inquiry into their structure, considers it most probable that they are dilatations of the lymphatic vessels of the spleen, from their analogy with the interior of a splenic or mesenteric lymphatic gland of an infant; and he thinks all that remains to verify the conjecture is an obvious connection with some lymphatic vessels, afferent and efferent. By Simon they are considered as aggregations of Cytoblasts.[3]

These corpuscles are seen with difficulty in the human spleen; in animals, they are much more distinct, as in the hog, sheep, and ox. Müller[4] admits their connection with the arteries, but is inclined to consider them as excrescences from their coats, as in his injections the arteries were seen to pass through, but not to ramify in them.

Their real existence has been much contested, owing to the uncertainty of finding them, but it now seems to be admitted that the best spleens for this purpose are such as are perfectly healthy, and taken from subjects who have died suddenly. A little delay disposes them to become putrescent, and more pulpy, as it does the red substance of this organ. Those of a brownish red are best suited for the investigation.

The spleen has many lymphatic vessels, and is furnished with nerves from the solar plexus.

The spleen, from having no excretory duct, and consequently, from our inability to ascertain whether it secretes, has its uses unknown.

[1] Malpighi, Ruysch, Hewson, Home, Dupuytren, Meckel, &c.
[2] Epis. Anat. IV.
[3] Brit. and For. Med. Rev. p. 567, April 1846.
[4] Physiol. p. 618.

No single theory concerning it has ever been generally adopted, for speculations have multiplied in proportion to the obscurity of the subject. By some it is thought to exercise merely a mechanical function—by others, a chemical one—by others, a dynamic—and, in the midst of such uncertainty, some have concluded that it had no special function. The hypothesis which to me is most reasonable is, that of its acting a subsidiary part to the liver. It would seem, indeed, as a general rule in regard to glandular structures and such other highly vascular organs of the body as have an intermittent function, that the blood which is sent to them during their state of activity should be passed off through a different channel, while they are in a state of repose. This does a double service; it prevents superfluous secretion, and it also keeps up the vascular equilibrium of the body; as there must be always in readiness a quantity of blood sufficient for the supply of any secretion which may be wanted for the time.

This proposition will derive some additional illustrations from the fœtal state. The kidneys being then inactive, the capsulæ renales take off their blood, and thereby prevent what would otherwise be a very inconvenient secretion of urine; again, the lungs being also then inactive, the circulation through them is proportionately reduced, and the superabundant blood is conducted through the thymus gland. But, as the full functions of the lungs and of the kidneys are established upon birth, and continue uninterrupted during life, their supplementary organs respectively, as the thymus gland, and the capsulæ renales, not being wanted, wither away after the early period of infantile existence is passed.

In regard to the liver, its functions, also suspended during the fœtal state, are of an intermittent kind throughout life; the spleen may, therefore, be considered a vicarious organ for it, during the whole period of existence—receiving its blood during the continuation of uterine life, and in the intermission of action during common life. The spleen is, therefore, an organ useful to the fœtal and to the perfect state, and we, consequently, never see it in the collapsed and effete condition of the thymus gland, and renal capsules. To the above may be added the opinion of Prof. Kölliker that it dissolves the red corpuscles of the blood, which may be in aid of the secretion of bile.[1]

The same reasoning which applies to the spleen will also apply to the Thyroid Gland: the latter may be considered as executing for the salivary glands, during fœtal and perfect existence, what the spleen does for the liver; for the salivary glands, being inactive during fœtal existence, have only an intermittent action during perfect life, and, therefore, probably stand in need of a supplementary organ during their periods of inactivity.

SECT. III.—OF THE PANCREAS.

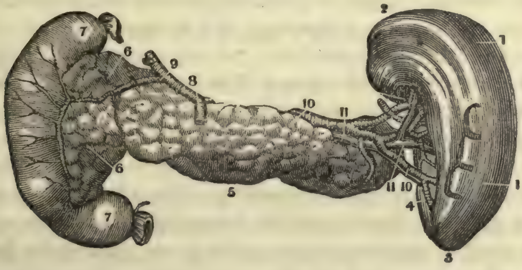
The Pancreas (*Pancreas*) secretes saliva, and is the largest of the salivary glands. According to Mr. Bernard of Paris, a peculiar fluid

[1] See Carpenter's Pr. Hum. Phys. p. 511, Phila. 1850.

destined to reduce fat to a digestible form, is its proper secretion instead of saliva. It is fixed in the lower back part of the epigastric region, and extends horizontally across the spine, being separated from it by the lesser muscle of the diaphragm. It is connected to the spleen on the left; at its right extremity is surrounded by the curvature of the duodenum; is bounded in front by the stomach, which conceals it, and is placed between the two laminæ of the mesocolon.

The pancreas is about six or seven inches long, two wide, and flattened before and behind. Its figure would be represented by a parallelogram, were it not that its right extremity is enlarged considerably into a head or tuber, to which Winslow gave the name of the Lesser Pancreas. The anterior face of this organ is turned obliquely upwards, and is covered by the superior lamina of the mesocolon. The posterior face looks obliquely downwards, and is in contact with the aorta, the vena cava ascendens, the superior mesenteric vessels, and several nerves: along the superior margin of this face exists a long superficial fossa, occupied by the splenic artery and vein.

Fig. 188.



An anterior view of the Pancreas, Spleen, and Duodenum, with their Blood-vessels injected.—1. The spleen. 2 Its diaphragmatic extremity. 3. Its inferior portion. 4. The fissure for its vessels. 5. The pancreas. 6. Its head, or the lesser pancreas. 7. Duodenum. 8. An artery to the stomach. 9, 10. The splenic artery. 11. The splenic vein.

With the exception of the loose covering given by the mesocolon, the pancreas has no peritoneal coat; neither has it an appropriate tunic, unless we consider as such the lamina of condensed cellular membrane which envelops it, and sends in processes between its lobules, as in the case of the salivary glands in the neck.

Of the Minute Structure of the Pancreas.—This body, like the other glands which discharge saliva, is of a light gray or pink color. It consists in lobes of various forms and sizes, united by an intermediate cellular tissue, and having their interstices occupied by numerous blood-vessels. These lobes are reducible into lobules, and the lobules, by a slight maceration, may be separated and resolved into small granular masses (*acini*), constituting integral portions of the gland.

The excretory duct of this gland (*ductus Wirsungii*) arises, by very fine roots or tubes, from each of the small granular masses. These roots have vesicular commencements like those of the salivary glands. The tubes coalesce into larger ones, which run transversely from the surface towards the central line of the gland, inclining slightly, at the

same time, towards the right. These secondary tubes finally discharge successively into a single one, which runs the whole length of the gland nearly in its middle. The single tube, by these additions, enlarges continually from left to right, being small where it begins at the splenic extremity of the pancreas, and about the size of a crow-quill at the duodenal. At the latter place, it is joined by the duct of the lesser pancreas, which is derived after the same rule as itself. The pancreatic duct, almost immediately afterwards, empties into the ductus communis choledochus; or runs at the side of the latter, and makes a distinct opening near it into the duodenum, at the posterior part of the second curvature.

The diameter of the cell-like extremities of the duct of the Pancreas is from six to twelve times greater than that of the capillary blood-vessels.

The arteries of the pancreas come principally from the splenic, as it cruises along the superior margin. The veins empty into the splenic, and thus, finally, into the vena portarum. It is furnished with nerves from the solar plexus, and has lymphatics.

BOOK V.

OF THE URINARY ORGANS.

The Urinary Organs (*organa oropoietica*), being destined to secrete and convey the urine out of the body, consist in the Renal Capsules, the Kidneys, the Ureters, the Bladder, and the Urethra.

Of the Renal Capsules.

The Renal Capsules (*capsulæ renales, renes succenturiati*) are two small bodies, one on either side, placed upon the upper end of the kidney. They are of a yellowish-brown color tinged with red, have no excretory ducts, and are more distinctly developed and softer in the perfect fœtus than in the adult; whence they are ranked among those organs, as the thymus gland, and others, which, having some peculiar value in fœtal existence, are perhaps unnecessary to that of the adult.[1] They are of a triangular pyramidal shape, flattened before and behind, and rest by a concave base upon the kidneys; they are about fifteen lines high and as many wide.

They are surrounded by a proper coat of lamellated dense cellular tissue, which, by detaching inwards its prolongations, keeps the parts of these bodies together, and marks out their divisions. In the centre of the renal capsule, a cavity may, occasionally, be found in the adult; but, according to my own observations, nothing in our structure is less certain than its existence; and, in the opinion of Meckel, when found, it is the result of cadaverous decomposition. In the fœtus it contains a reddish viscid fluid, which seems to consist in a large share of albumen, as it coagulates with alcohol; in children, this fluid becomes yellow: in adults it is dark brown; and in old people it is either entirely deficient, or in a remarkably small quantity.

Of the Minute Structure of the Capsulæ Renales.—The arteries of these bodies come from the emulgents, from the phrenics, and from the aorta. The veins of the right one terminate in the cava ascendens, and of the left in the left emulgent. Each capsule is divisible into

[1] This opinion has been confirmed in a dissection of a fœtus, where I found the capsulæ renales, though the kidneys were absent.

lobes, and by a slight maceration may be reduced into lobules and small granulations. The granulations seem to have an intimate connection with the veins, as they are easily penetrated by fluid injections from the latter. The external part is rather more consistent and yellow than the internal; hence, a division has been adopted into cortical and medullary portions.

In the cortical portion, the minute arteries and veins are about the size of the capillaries of other parts, and are of nearly uniform magnitude. They are arranged in a radiated manner, so as to run in lines from the surface towards the centre. The arteries anastomose with the adjoining branches, so as to form very long meshes: the veins do the same. On the periphery of the organ there is an ordinary capillary net-work of vessels. A spongy venous tissue composes the greater part of the medullary or more interior portion; this spongy tissue receives the radiated venous branches of the exterior, and discharges its own blood into a large vein (*vena supra-renalis*) in the interior of the organ. Müller,[1] in addition to the above, says that the only cavity in this organ is the vein just alluded to, and that by forcing air into the vein the whole medullary tissue may be distended.

According to the researches of Professor Ecker of Bâsle,[2] these bodies exhibit everywhere closed glandular vesicles, formed of a structureless membrane and containing albuminous substance. This substance is partly fluid and partly granular, having in it cells and nuclei. The nuclei are either free or have an envelop. There are numerous fatty particles in the cells.

The Renal Capsule, Professor Ecker admits to consist of cortical and medullary substance. In man, the vesicles are found only in the cortical substance, and are frequently tubular in their shape, being disposed end to end. The medullary part, he says, is composed of conjunctive fibres, vessels, and very numerous nerves, and the interstices of this net-work are filled by the same material, found in the vesicles of the cortical substance.

The elements of the gland furnish a fluid rich in protein and in fat, which, he thinks, are discharged into the vascular system by exosmose or by dehiscence of the vesicles, and contribute to nutrition.

The preceding observations confirm the views of Professor Goodsir,[3] that the thyroid and the thymus glands and the Renal Capsules are of essentially similar structure; they being, along with the Wolffian bodies, the development of the remains of the Blasto-derma, situated along the spine. They are considered by him as serving the function of nutrition, by withdrawing certain materials from the circulating fluid, elaborating and then quickly restoring them again to the circulation by lymphatics.

The thyroid, the thymus, and the supra-renal bodies are derived from the membrana intermedia of the Blasto-derma, and are originally all connected together, but finally disjoin.

Examination with the microscope, by Mr. Gulliver,[4] exhibited the

[1] Physiol. p. 621.
[2] British and For. Med.-Chir. Review, Oct. 1848, p. 525.
[3] Phil. Transact. &c. 1846, p. 633.
[4] Gerber's General Anatomy, Appendix, p. 103, London, 1842.

proper structure or pulp as formed of spherules, from the $\frac{1}{2400}$th to the $\frac{1}{8000}$th of an inch.

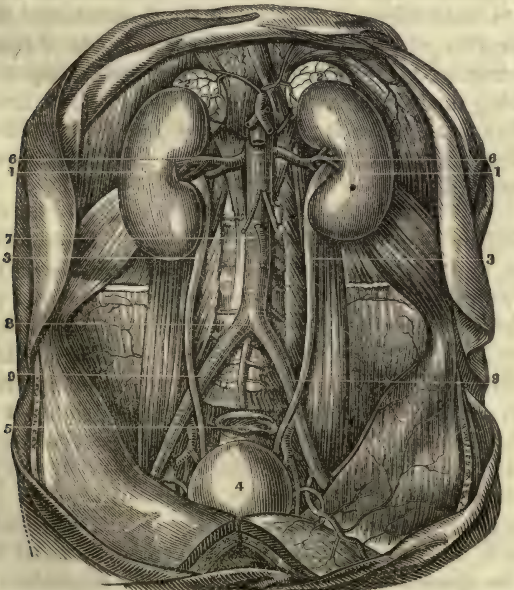
Alleged excretory ducts for these bodies have been found going to the testicle, to the pelvis of the kidney, and to the thoracic duct, but no credit is now attached to such assertions.

Of the Kidneys.

The Kidneys (*renes*) are two glandular bodies for the secretion of urine, fixed one on either side of the spine. They are in the back part of the lumbar regions, have their internal edges inclining very slightly forwards, and extend from the upper margin of the eleventh dorsal to the lower margin of the second lumbar vertebra: the right, however, is ten or twelve lines lower than the left, owing to the thick posterior margin of the right lobe of the liver, which presses it downwards. The Kidneys are covered in front by the peritoneum and the lumbar portions of the large intestine, but in such a manner as to be separated from them, in corpulent subjects, by a surrounding layer of fat; behind, they repose upon the lower part of the great muscle of the diaphragm, upon the quadrati lumborum, and upon the upper end of the psoæ magni muscles.

The kidney is a hard solid body, of a brown color; in shape it is a compressed ovoid, excavated on the margin which it presents to the spine, and bears a very strong resemblance to the common kidney bean. Its flat surfaces present forwards and backwards, and the broad end of the ovoid is above. Its periphery is smooth, so that one does not infer,

Fig. 189.



A view of the Urinary Organs *in situ*.—1, 1. The kidneys. 2, 2. The capsulæ renales. 3, 3. The ureters in their course to the bladder, and their relation to the blood-vessels. 4. Bladder distended with urine. 5. The rectum. 6, 6. The emulgent arteries. 7. The abdominal aorta. 8. Its division into the primitive iliacs. The primitive iliacs at the point where the ureters cross them.

from an external examination, the lobules or internal divisions. The excavation of the kidney, next to the spine and called its fissure (*hilum renale*), occupies about one-third of its long diameter, is bevelled in front, and leads to the very interior of the gland, and produces there a very extensive excavation or sinus, occupied by the blood-vessels and excretory duct, which have to pass through a quantity of cellular and adipose matter. The kidneys are generally of equal size, being about four inches long, and two and a half wide, and each one weighs three or four ounces. The size, however, depends much on the amount of fat within their fissure or sinus. They have no ligaments for keeping them in position, but depend for the latter upon the adjacent cellular adhesions and blood-vessels.

The kidney, being destitute of a peritoneal coat, has a well-marked capsule (*tunica propria*) which envelops it entirely and penetrates into its fissure for some depth, where it is perforated with foramina for transmitting the blood-vessels and the excretory duct. This capsule is thin, white, semi-transparent, fibrous, dense, and elastic; it adheres to the surface of the kidney by delicate cellular and vascular filaments, which are so weak that they permit it to be stripped off without difficulty, and, when so removed, some indications of a lobulated condition of the organ are seen.

Of the Minute Structure of the Kidney.—The lobulated state of the kidney is well marked in the fœtus,[1] and in some of the lower orders of animals, as the bullock, exhibit it very clearly through life. In the human adult subject, by tearing the kidney up according to the superficial lines marking a tendency to the lobulated condition, it will be found that there are really about fifteen divisions of it, more or less, each of which constitutes a small kidney (*renculus*). When the kidney is cut open longitudinally, it obviously consists of two kinds of substance, differing in their situations, color, consistence, and texture. The one making the periphery of the gland is called from its position Cortical (*substantia corticalis; glandulosa*), while the other, being more internal, is designated as the Medullary or Tubular (*substantia medullaris; tubulosa; fibrosa*).

The Cortical or Secretory Substance forms the whole circumference of the kidney, and, on an average, is about two lines in thickness; but it is thicker at some points, as, from its internal face, processes converge towards the centre of the gland, which separate the tubular part into as many distinct portions of a conoidal shape. It is composed largely of arteries and veins and the incipient ends of the uriniferous tubes all ramifying, among small granular corpuscles (*corpora Malpighiana*, or *glomeruli*). It tears with facility, thereby presenting this granular appearance, and is of a dark or reddish-brown color, varying considerably, however, according to the cause of death.

These Granular corpuscles in the mass of the cortical or secretory substance are of but small size, and lie imbedded in their loose capsules. Their shape is spheroidal or oblong, and their diameters are from the $\frac{1}{270}$th to the $\frac{1}{120}$th of an inch. They are very distinct when viewed

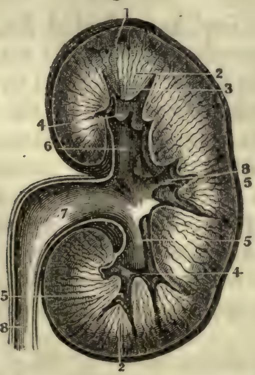
[1] It is sometimes found in the adult in the same lobulated state.

with a microscope, and present themselves as innumerable small round points, more red than the other portions of the surface inspected. They are attached to very fine arterial twigs, like a berry to its stem, and are so disengaged in their position in the cortical part of the kidney, that they may be lifted out of their beds with the point of a needle, especially in the horse.

The celebrated Ruysch, who was distinguished for the success of his injections, and for the acuteness of his vision, declared that they consisted wholly in clusters of very fine extremities of arteries and veins having a penicillous or brush-like arrangement; while Malpighi and Schumlansky viewed them as purses or small sacs of a glandular character, specifically suited to secrete urine, and upon whose parietes the blood-vessels ramified. From these granuli or acini the incipient extremities of the tubuli uriniferi, they asserted, take their rise.

The Tubular or Conoidal Substance consists in from twelve to eighteen conoidal fasciculi, say on an average fifteen (*pyramides Malpighianæ*), presenting their rounded bases towards the cortical matter, and inclosed in it, while their apices converge to the central cavity of the kidney, the surface of which they form. The bodies of these pyramids, as just mentioned, are separated by processes of the cortical matter; but their apices are free, and project from the internal surface of the kidney so as to resemble as many small nipples, whence they are called Papillæ or Mammellæ Renales. Frequently two of the pyramids coalesce so as to form but one papilla together; in such case the latter generally preserves a duplicate appearance. The papillæ are arranged into three vertical rows, one before, one in the middle, and another behind; those of the foremost row are turned backwards; those of the middle look inwards; and those behind look forwards. Not unfrequently, there is a small depression (*foveola*) on the very summit of the papilla. The tubular part is of a lighter color and harder than the cor-

Fig. 190.



A vertical section of the Left Kidney.—1. Cortical or vascular structure. 2. A pyramid of Malpighi or tubular structure. 3. Papilla or apex of a pyramid. 4, 5, 5, 6. Calices and their infundibula. 7. Pelvis of the kidney. 8. The ureter.

tical, but the difference in these respects is not always manifest and sometimes is reversed.

The conoidal fasciculi may each be considered, along with its appertaining cortex, as a sort of distinct gland (*renculus*), or at least as a lobe; for upon them depends the lobulated appearance as stated of the kidney of a fœtus, and of animals. Each cone, when analyzed, is found to consist in a collection of tubes (*ductus uriniferi Bellini*) converging from the circumference of the kidney to the apex of the papilla. These tubes are more numerous near the base of the cone, in consequence of their successive junction subsequently in approaching the apex:[1] their terminating orifices, on the latter, appear like small pores from which the urine can be squeezed in little drops.

In the early part of the course of the ductus uriniferi, while they are still in the cortical matter, they proceed in a very serpentine and tortuous manner, and are distinguished by the name of Cortical Canals (*ductus Ferrenii*).[2] They there commonly go alone, winding their way in the cortical substance until they reach its most interior face; they then become straight, form the tubular substance, and have the name of the conduits or uriniferous ducts of Bellini.[3]

Some of the calculations on this subject are not a little curious. It was ascertained by Ferrein that in each of the conoidal fasciculi (*pyramides Malpighianæ*) there were at least seven hundred subordinate cones or pyramids (*pyramides Ferrenii*), and as the number of conoidal fasciculi is generally about fifteen, these pyramids would amount to ten thousand five hundred. Again, each of the subordinate pyramids is composed of many hundred uriniferous tubes, and, by the observations of Eysenhardt,[4] each of these tubes consists of twenty smaller ones.

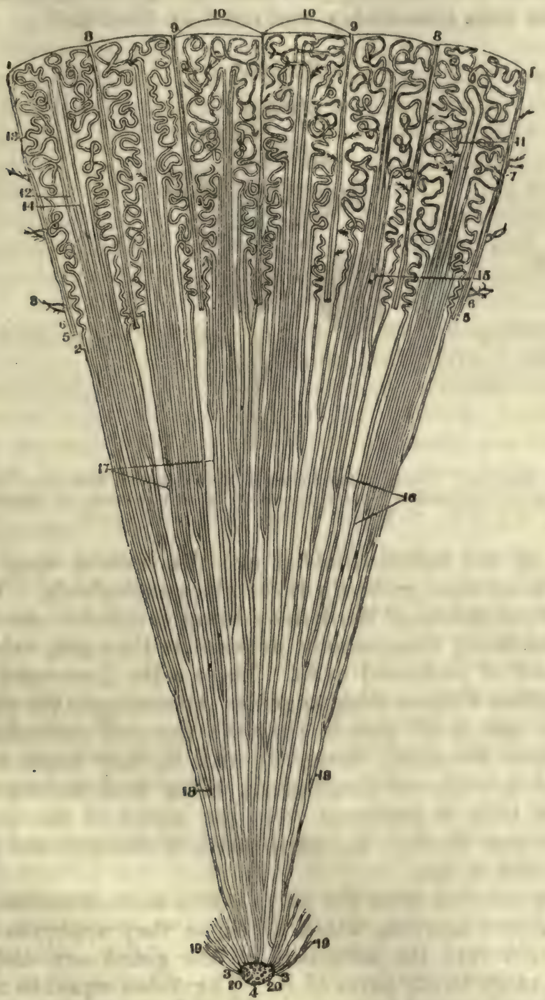
The cortical canals or ducts of Ferrein, it is believed by many, terminate at their peripheral extremity, by forming loops upon themselves, and anastomoses with contiguous similar canals.[5] It is also held by some, as Wagner, that in addition to this mode of termination others of those canals end in cœca or blind extremities, which are either single or bifid. Should the observations in this respect turn out correct, the arrangement has been found at least more decided and frequent, in the lower animals, than in man.

Huschke[6] and John Müller[7] have denied the connection of the Malpighian or Granular corpuscles (*glomeruli*) with the Ducts of Ferrein. The former says that if the ureter be injected by the pneumatic machine, the injection will be found never to reach the Malpighian corpuscles, though an injection of the arteries at the same time will, and the two injections will remain apart. He hence infers that these bodies are merely the twisted tufted ends of the blood-vessels, being an arrangement preparatory to the real secretion of urine from a subsequent capillary net-work made of arteries and of veins. The net-work surrounds the cortical canals, and is displayed upon them, without, however, anastomosing with them. In opposition to this view, besides the testimony

[1] Schumlansky, Diss. de Struct. Renum, Strasburg, 1782.
[2] A. Ferrein; sur la Structure des reins et du foi, Mém. de l'Ac. des Sc. Paris, 1749.
[3] L. Bellini, de Structura Renum, Florence, 1662.
[4] De Struct. Renum Obs. Micros. Berlin, 1818.
[5] Müller, Krause, Owen, Weber. See Müller's Physiol. 2d ed. p. 496.
[6] Traité de Splanch. p. 298.
[7] De Gland. Struct. Leips. 1830.

of preceding anatomists, we have a very good paper, by Mr. Bowman, of King's College, London,[1] showing by injections this connection of

Fig. 191.



A section of one of the Pyramids of Malpighi, and of its corresponding Cortical Substance, as seen under the Microscope. 1. Portion of the surface of the kidney. 2. From this figure up to 1, is the Cortical substance of the kidney. 3. From 2 to this number is the tubular portion. 4. The foveola. 5, 6. Arteries and veins ramifying through the kidney. 7. Arteries to the acini of the kidney. 8. Capillary extremities of veins anastomosing with corresponding arterioles. 9. Tortuous extremities of the arteries directed into the interior of the gland. 10. Bases of the cones of the cortical and pyramidal substance of the kidney: from 10 to 4 is a collection of these cones. 11. The envelop of the cortical layer. 12. Prolongations of the tubular portion. 13. Tortuous tubes or those of Ferrein. 14. Straight tubes, or those of Bellini. 15. Vessels which wind between them. 16. Course of the uriniferous tubes in the tubular portion. 17. The matter between these tubes. 18. Bifurcation of the straight tubes. 19. Sections of these tubes. 20. Their orifices.

the corpuscles and the ducts of Ferrein; and that the arteries and veins make there a tufted junction with one another. He asserts that each

[1] Transactions Royal Society, London, part 1st, 1842.

one of these corpuscles is actually included in the extremity of a uriniferous tube, which enlarges to receive it; that the arterial filament that supplies it after forming its tuft emerges as an efferent trunk, and is then merged in the capillary plexus investing the uriniferous tubes. This view has been measurably confirmed by Gorlach.[1]

Fig. 192.[2]

Arrangement of the Renal Vessels in the Kidney of the Horse.—*a*. Branch of renal artery. *af*. Afferent vessel. *m*, *m*. Malpighian corpuscles. *ef*, *ef*. Efferent vessels. *p*. Vascular plexus surrounding the uriniferous tubes. *st*. Tube of Bellini. *ct*. Tube of Ferrein.

The walls of the tubuli uriniferi are the surface upon which the secretion of urine most probably takes place exclusively. The mucous membrane of the pelvis of the kidney being continued over them so as to form the surface; these canals, delicate as they are, exhibit an epithelium formed of nucleated cells. These cells, discovered by Henlé, are close together without being angular. According to the physiological views of the case in all glands, they are the real elaborators of the urine, and upon becoming distended with it, they burst, and let out their contents into the tubuli uriniferi; being then decomposed, a new generation of cells is produced from the nuclei of the extinct ones. They have to pass through the same series of changes, and thus it proceeds to the end of life.

The kidney receives from the aorta one or more branches, called the renal or emulgent arteries, which divide as they approach the fissure, and having got into the substance of the gland are distributed by innumerable twigs to all parts of it. The veins equal in number the arteries, and are somewhat larger. When both, or even one, of these systems of blood-vessels is injected with wax and corroded, its branches are so abundant as to retain the form of the gland. In engaging in the fissure of the kidney, the arterial ramifications are in front, the veins in the middle, and the commencement of the ureter behind.[3] The artery on the right side is longer than that on the left. The reverse is the case with the emulgent veins, as they empty into the vena cava ascendens. This arrangement is owing to the relative posi-

[1] Am. Journ. Med. Sciences, p. 442, April, 1846.
[2] According to Bowman, magnified about thirty diameters.
[3] This rule is subject to frequent variations.

tion of the aorta and the vena cava ascendens, as the first is on the left side of the spine, and the last on the right side.

The arteries of the kidney, in ramifying minutely through its structure, adopt the following arrangement. They first of all pass through the processes sent inwards from the cortical matter between the pyramids of Malpighi, or large cones, and, having got fairly into the cortical matter, they divide into very fine twigs, which form arcades around the bases of the pyramids of Ferrein, and pass between them.[1] These arcades have anastomoses with each other, and their larger branches go almost exclusively to the cortical substance, but few of them being found on the tubular. The branches radiate from the convexities of the arches, so as to surround the base of each cone, and to penetrate to the surface of the kidney. Some of these branches terminate in corresponding veins, and others on the granular corpuscles or acini.

The veins penetrate the substance of the kidney, and have a similar distribution; but they are much larger than the arteries, and have free, large, and numerous anastomoses. A connection of the corpuscles with the veins is not quite so evident, and, after due allowance to the suggestions of Mr. Bowman, remains yet to be adequately proved, in the opinion of many anatomists. The fact, however, is well established, that fine injections will readily pass from the veins into the tubuli uriniferi, and that air blown into the ureter will pass readily into the veins. In my own injections these have been done repeatedly, and the corpuscles of Malpighi are seen very distinctly to be formed of convoluted arteries. I have not seen the veins convoluted under the same arrangement, neither have I succeeded in tracing the cortical canals to these corpuscles or acini.

From the concave side of the arterial arcades very fine capillary branches converge in company with the ducts of Bellini in a line with them, and penetrate to the free surface of the papillæ renales. Upon this surface is made a highly attenuated capillary intertexture, the meshes of which surround the orifices of the tubuli uriniferi. The converging arteries anastomose across the tubuli, making elongated meshes. A similar arrangement of the veins takes place from their cortical branches and arcades, it being in company with the arterial arrangement. The facility of injecting these minute tubular arteries and veins has frequently given rise to the mistake of considering them as the tubuli uriniferi themselves; an error which has been pointedly marked out by Müller.[2]

The nerves of the kidneys come from the solar plexus of the sympathetic; and adhering to the arteries cannot be traced very far through the glandular structure. The quantity of lymphatics is considerable.

The kidneys are subject to a false position; in one instance, I found in a young female subject one of the kidneys in the pelvis in front of the rectum. A similar case has been seen by Professor Hensinger,[3] and since then, others have been recorded. I have met with several instances of a coalition of the two kidneys, across the spine, so as to present the appearance of a bilobed organ.

[1] Schumlansky. [2] Physiol. p. 225.
[3] Amer. Med. Jour. vol. iii. p. 442.

It appears that, in the Boa Constrictor, there is a vena portarum to the kidney—some approach to which Bowman considers to exist in the human subject, under an arrangement stated by him.

Of the Excretory Duct of the Kidney, or the Ureter.

The Ureter is a canal which conveys the urine from the kidney to the bladder. It commences in the centre of the kidney by an enlargement called *pelvis*, which branches off into three or four portions, (*calices*), one above, one below, and one or two intermediate. Each of these calices is divided, at its free extremity, into three or four short funnel-shaped terminations (*infundibula*). Each of these terminations embraces, by its expanded orifice, the base of a papilla renalis, so as to permit the latter to project into it, and thereby to distil its urine there. Very frequently the number of papillæ exceeds that of the infundibula, in which case two of the former project into one of the latter.

The pelvis of the kidney having emerged at the fissure behind the vessels, from being expanded and conoidal in shape is reduced to a cylindrical canal, which, properly speaking, is the ureter; the latter is about the size of a goose-quill, and descends through the lumbar region, between the peritoneum and the psoas magnus muscle. It dips into the pelvis by crossing in front of the primitive iliac vessels and the internal iliac, crosses the vas deferens at the back of the bladder, and penetrating obliquely the coats of the latter, terminates in an orifice ten or twelve lines behind that of the neck of the bladder.

The excretory duct of the kidney is formed by two coats. The external is a dense, fibrous, and cellular tissue, but is destitute of anything like muscle. The internal is a thin mucous lamina, coated internally with rounded epithelial scales, which can be raised up without much difficulty, and is continuous, at its lower end, with the internal coat of the bladder; at the upper end, it is admitted by some anatomists to be reflected over the papillæ renales, and even to pass for some distance into the tubuli uriniferi; it adheres to the capsule or proper coat of the kidney, at the base of the papillæ. This duct has considerable powers of extension, as manifested by its transmitting large calculi from the kidneys, and also by its enormous enlargement in some cases of obstructed urethra.[1] Its sensibility is exquisite when irritated by a calculus passing down it.

Corpora Wolffiana.

The Corpora Wolffiana, called after their discoverer, C. F. Wolff, are small bodies found only in the earlier stages of fœtal life, one on each side in the lumbar region, and of which there are scarcely any traces at the end of the fifth month. When in full development, they are so large as to conceal the kidneys and the renal capsules, but as these latter organs grow, the corpora Wolffiana diminish, and are finally placed lower down. They are supposed to be vicarious kidneys for the time, and they consist in transverse cœcal tubes, which are numerous.

[1] See Wistar Museum.

They have each an excretory duct, which leads from their lower part into the Sinus Uro-genitalis.

Fig. 193.

Corpora Wolffiana, as shown in the Embryo of Birds, with the Kidneys and Testes.—1. Kidney. 2, 2. Ureters. 3. Corpus Wolffianum. 4. Its excretory duct. 5, 5. Testicles.—On the top of the figure are seen the supra-renal capsules.

The Wolffian bodies are in the highest state of development in the human fœtus in the fifth week; they shrink from that time, and have disappeared considerably even at the end of the second month. But remnants of their tubular structure are found in females after birth, situated near the ovary in the folds of the broad ligament of the uterus, constituting what is called the organ of Rosenmuller. Prof. Kobelt, of Fribourg, declares that the same continues through life as an appendage to the ovary, very analogous to the epididymis of the male. Having seen some of his preparations, I have only to admit the accuracy of his assertion. Rathke and Kobelt both assert that the epididymis and the vas deferens are formed from its middle part.

The Sinus Uro-genitalis is also peculiar to the fœtal state, and is a tube which for the time receives from each side the ureter, the vas deferens, and the duct of the corpus Wolffianum; and is prolonged into the urachus. The Sinus Uro-genitalis is finally divided into two branches, from one of which is evolved the urinary bladder, and from the other the vesiculæ seminales.[1]

The Wolffian Bodies are derived from the membrana intermedia (of Rathke) of the embryonic blastoderma, and are the last of the organs coming from it which assume a special structure. The thymus, thyroid and supra-renal capsules coming from the same source, retain prominently the original structure from which they are derived.[2]

Of the Bladder.

The Bladder (*vesica urinaria*) is the reservoir for the urine, and is placed in the pelvis, just behind the symphysis of the pubes. When pressed upon, as it commonly is, by the adjacent viscera, it is flattened somewhat before and behind; but removed from the body and inflated,

[1] Müller's Phys. p. 1639.
[2] Mr. J. Goodsir, Philos. Transactions, 1846.

it is an elongated sphere or an oval: the greatest diameter of which is vertical, in regard to the linea ileo-pectinea. The superior end of the bladder is called the upper fundus, and the lower end the inferior fundus; the latter is rather more obtuse than the other, and between the two is the body. The neck of the bladder is its place of junction with the urethra. The form of the bladder is influenced by age and by sex; in very young infants it is cylindroid, and owing to the smallness of the pelvis, rises up almost wholly into the abdomen. In the adult woman, who has frequently borne children, it is nearly spherical, has its greatest diameter transverse,[1] and is more capacious than in man.

The bladder is bounded in front by the pubes, above by the small intestine, behind by the rectum, and below by the prostate gland and the vesiculæ seminales. From its superior end there proceeds to the umbilicus a long conical ligament, the urachus, which is placed between the linea alba and the peritoneum, and produces a slight elevation or doubling of the latter. In mankind, the urachus is solid; but some very rare cases are reported, in which it has been hollow, so as to permit the urine to flow through it from the bladder. This anomalous conformation has generally been attended with a congenital obstruction of the urethra.[2] When the anterior parietes of the abdomen are put upon the stretch, a semilunar fold of the peritoneum, as formerly mentioned, is seen to proceed, on either side of the urachus, from the lateral surface of the bladder almost to the umbilicus. These folds contain, in their free edge, the fibrous remains of the umbilical arteries of the fœtus, called, subsequently to uterine life, the Round Ligaments of the bladder, though they have little or no influence on its position. The bladder is also fixed in its situation by the pelvic aponeurosis, a membrane elsewhere described with the organs of generation.

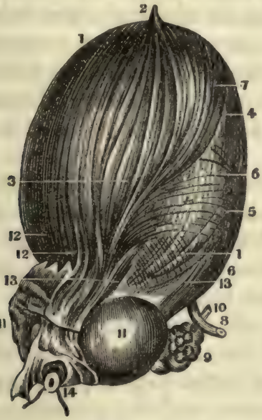
The bladder consists of four coats: the Peritoneal, the Muscular, the Cellular, and the Mucous.

The Peritoneal Coat is very imperfect, and is derived from the part of the peritoneum which descends from the anterior parietes of the abdomen into the pelvis. It covers the upper and the posterior face of the bladder, and then passes to the rectum, by sinking down between these two organs, so as to form the small pouch beneath the lower fundus of the bladder; the apex of this pouch reaches within an inch of the base of the prostate. The upper margin of this pouch next to the bladder forms a strong horizontal doubling, stretching across the pelvis, when the rectum is empty, and is on a level with the posterior end of the vesiculæ seminales. Being connected to the subjacent muscular coat by a thin lamina of loose cellular membrane, the peritoneum may be dissected off without difficulty. In considerable distensions of the bladder, it is reflected from the upper end of the latter to the abdominal muscles in a line much above the pubes; whereby a good opportunity is afforded of reaching, with an instrument, the cavity of the bladder without injuring the peritoneum.

[1] H. Cloquet, Anat. Descrip.
[2] Sabatier, Anat. vol. iii. p. 19.

The Muscular Coat is of a thickness intermediate to that of the stomach and of the œsophagus, and its fibres are pale. They pass in very varied directions,[1] and are collected into flattened fasciculi, leaving interstices between them, through which the internal coat is occasionally caused to protrude, in strictures and other obstructions of the urethra. Many of these fasciculi arise about the neck of the bladder, and, ascending upwards, before, behind and laterally, terminate at the superior fundus in the base of the urachus. Within these, which may be considered as the longitudinal fibres of the bladder, there are others forming a thinner lamina, whose course is transverse or oblique: they serve to connect the preceding. As the muscular fibres are collected at the neck of the bladder, and at the urachus, there is, of course, an increased thickness at these points.

Fig. 194.



A three-quarter view of the Urinary Bladder, distended with Air and showing its Muscular Fibres. 1, 1. The bladder. 2. Urachus. 3. Two planes of longitudinal muscular fibres on the anterior and external portion of the bladder. 4. A band of fibres separating from these and running upwards and outwards. 5. Muscular fibres which form loops on the posterior surface of the bladder. 6. Other muscular fibres forming a layer between the external, 7, and the internal. 8. Left ureter. 9. Left vesicula seminalis. 10. Vas deferens of the same side. 11, 11. The lateral lobes of the prostate gland. 12, 13. Muscular fibres which ascend. 14. The urethra tied with a cord.

The Cellular Coat (*tunica propria*) like that of the alimentary canal consists in a close, dense, lamellated, and filamentous cellular tissue, very extensible and rather difficult to tear. It contains a considerable quantity of elastic fibre in its coiled and characteristic state; adheres closely to the muscular coat without, and to the mucous within, so as to form a strong bond of union between them. It is pervaded by many vessels and nerves, which it conveys to the mucous coat.

The Mucous Coat is also called the villous, but is much more smooth than the corresponding one of the stomach. It is white, with a slight tinge of red, and abounds with mucous follicles, which, though small and scarcely discernible in a natural state, are rendered very obvious by disease. It stretches with much facility, but, like other mucous membranes, does not restore itself fully, and is rather thrown by the

[1] Santorini, Septemd. Tabul.

contracted state of the bladder, into wrinkles or folds, having a diversified course, and of a fugitive character, as they disappear again upon the next distension. It is very vascular.

The internal face of this coat presents, at its inferior part, the following appearances:—

1. The Vesical Triangle (*trigonus Lieutaudi, trigone vesicale*) is placed immediately behind and below the neck of the bladder, occupying the space between it and the orifices of the ureters. It is an equilateral triangle of an inch in length; its surface is smooth, is not affected very materially in extent either by the dilatation or the contraction of the bladder, and is elevated so as to be sufficiently distinct and well defined.

2. The anterior angle of the triangle looks into the orifice of the urethra, and is generally so elevated that it has obtained the name of Uvula Vesicæ; it is, however, simply a projection of the mucous membrane depending upon the subjacent third lobe of the prostate; which, at this point, is not unfrequently much enlarged in the aged, and then causes great difficulty in the introduction of a catheter.

3. The Orifices of the ureters form the posterior angles of the triangle, and are contracted somewhat below the size of the canals themselves. They are said, by Sir Charles Bell,[1] to be furnished, each one, with a small fasciculus of muscular fibres, which runs backwards from the orifice of the urethra, just beneath the lateral margins of the triangle, and, in its contraction, will stretch the orifice of the ureter so as to permit an easy passage of the urine into the bladder. The retrogradation of the urine is prevented by the ureter passing obliquely, for six or eight lines, between the muscular and the mucous coat. There is something also in the obliquity and elliptical shape, with a defined edge of the orifice itself, which assists in this effect; as I have ascertained by removing the muscular coat entirely, at this point, and dissecting up the ureter, notwithstanding which, the bladder, when inflated, still retained its contents. This orifice presents indeed some approximation to the ileo-colic valve, by having sharp edges on each side: the distension of the bladder in the length of it especially brings these edges closer together and thereby stops the retrogradation of urine. Where the ureter penetrates the muscular coat, there is often found a layer of longitudinal muscular fibres ascending and enveloping it for half an inch, or an inch. It is upon much the same plan as that seen in the cremaster in regard to the spermatic cord.

4. The Inferior Fundus of the bladder (*bas-fond* of the French) is a depression of the general concavity of the bladder, of about six lines in depth, placed between the base of the vesical triangle and the posterior side of the bladder. In the erect position, calculus, when present, lodges there.

[1] Med.-Chir. Trans. vol. iii.

5. The Internal Orifice of the neck of the bladder resembles strongly that of a Florence flask, modified, however, by the projection of the uvula vesicæ, which makes it somewhat crescentic below. The neck of the bladder penetrates the prostate gland, but at its commencement is surrounded by loose cellular tissue containing a very large and abundant plexus of veins.[1] The internal layer of muscular fibres is here transverse; and they cross and intermix with each other in different directions, forming a close compact tissue, which has the effect of a particular apparatus for retaining the urine, and is called Musculus Sphincter Vesicæ Urinariæ. Generally, anatomists have not considered this structure as distinct from the muscular coat at large; but the late Sir Charles Bell, Professor in the University of Edinburgh, whose reputation as an anatomist was well established, gives the following account of it:—

"Begin the dissection by taking off the inner membrane of the bladder from around the orifice of the urethra. A set of fibres will be discovered, on the lower half of the orifice, which, being carefully dissected, will be found to run in a semicircular form round the urethra. These fibres make a band of about half an inch in breadth, particularly strong on the lower part of the opening, and, having mounted a little above the orifice, on each side, they dispose of a portion of their fibres in the substance of the bladder. A smaller and somewhat weaker set of fibres will be seen to complete their course, surrounding the orifice on the upper part; to these sphincter fibres a bridle is joined, which comes from the union of the muscles of the ureters."[2]

After repeated observations on this point, I have come to the conclusion that Mr. Bell has indicated a real structure; but my own dissections have resulted as follows. The inferior semicircumference of the neck of the bladder is defined by a thick fasciculus of the non-striated muscular fibre (*transversus vesicæ*) half an inch wide, running in a transverse direction, and having its ends attached to the lateral lobes of the Prostate Gland, being above the third lobe of the latter, but intimately blended with it, so as to be a part of it, which may be seen by raising the triangularis vesicæ muscle, and by passing something between the bladder and that part of the prostate. This fasciculus is perfectly distinct from the ordinary muscular fibre of the bladder, and resembles in its appearance the yellow-fibrous coat of the arteries. The superior semicircumference is also surrounded by a thin layer of muscular fibres of the ordinary kind, belonging to the bladder, forming a broad, thin band of a crescentic shape (*semi-ellipticus vesicæ*) the lower ends of which are insensibly lost in the adjacent muscular coat of the bladder by being spread out. Lastly, beneath the mucous membrane of the vesical triangle, there is a triangular muscle (*triangularis vesicæ*) of the same size as the vesical triangle. Having elongated angles, the anterior angle may be traced to the posterior part of the caput gallinaginis, and the posterior angles to the orifices of the ureters and the adjacent part of the bladder. The texture of this muscle also looks like that of the middle or fibrous coat of the

[1] Mascagni, Anat. Magn. Str. Prim. Tab. Spec. Fig. V.
[2] Diseases of the Urethra, &c. p. 10, Lond. 1820.

arteries. When a bladder is sound, this detail of structure is made out with ease: but it requires to be previously hardened in spirits of

Fig. 195

Sphincter Apparatus of the Neck of the Bladder.—1, 1. Orifice of the neck of the bladder. 2, 2. Orifices of the ureters. 3, 3. The triangular muscle (triangularis vesicæ) under the vesical triangle. 4, 4. The semi-elliptical muscular plane at the neck of the bladder. 5. The transverse fasciculus of muscular fibres.

wine. That a power exists in the neck of the bladder of retaining completely the urine, has been satisfactorily demonstrated to me in a case of fistula in perineo, which was presented to the notice of the late Dr. Physick and myself, some years ago,[1] as well as in other cases occurring since then. The insertion of the muscle of the vesical triangle into the caput gallinaginis has a double effect; which by drawing the caput back fills up the front of the neck of the bladder; and by easing the orifices of the ductus ejaculatorii allows a free exit of semen, while it prevents the latter from retrograding into the bladder.

Occasionally there exists on each side of the neck of the bladder, passing from it to the pubes, a muscle of half an inch in breadth, the effect of which is to draw the neck of the bladder towards the symphysis pubis. This, called by some the muscle of Wilson, or the Compressor Urethræ, has also an influence in retaining the urine. When it exists in a distinct state it is evidently the anterior fasciculus, more detached than usual, of the Levator Ani; but under ordinary circumstances it appears as the anterior margin of that muscle, and therefore does not attract especial attention.

As the urethra of the male performs the double office of conducting both semen and urine, it will be described more properly along with the organs of generation.

The urine has a considerable number of constituents, the proportion of which varies according to age, health, and other circumstances. Water forms about nine-tenths of it, the remainder is an animal matter insoluble in alcohol; uric and lactic acids; lactate of ammonia; sulphate of potash and of soda; hydrochlorate of soda and of ammonia; phosphate of soda and of lime; and fluate of lime.

[1] Chapman's Med. and Phys. Journ. 1824.

BOOK VI.

ORGANS OF GENERATION.

CHAPTER I.

OF THE ORGANS OF GENERATION IN THE MALE.

THE Male Organs of Generation consist in the Testicles and in the Penis, with their appendages; or, in the language of some anatomists, in the Formative and in the Copulative Organs; which distinction has been applied to both sexes.

SECT. I.—OF THE TESTICLES.

The Testicles (*Testes*, *Didymi*) are two in number, one for each side of the scrotum. Being the seat of the secretion of sperm or the male prolific liquor, their function is of the first importance in the act of generation. They are of an oblong oval form, somewhat compressed laterally, and present their edges forwards and backward. From being suspended near the middle of their posterior edge by the spermatic cord, the upper end points somewhat forward, while the lower one is directed in the same degree backward. They are about an inch and a half long by one inch in breadth, and eight or nine lines in thickness. They are of equal size generally, but in case of a difference it is in favor of the right; the latter is also remarkable for being suspended higher than the left, a feature in ancient statuary so universal, as to prove the vigilance and accuracy of the sculptors of that period, in regard to the proportions and peculiarities of the human form. "Two obvious advantages attend this arrangement; one, that of the testicles passing each other without collision when the thighs are brought together; and another, the facility of keeping the penis to one side, instead of straight forward in the middle line of the body."[1]

The testicle is enveloped by several tunics; they are the Scrotum, the Dartos, the Tunica Vaginalis, and the Tunica Albuginea.

[1] Sir A. Cooper on the Testis, 1830.

The *Scrotum* is merely a continuation of the common skin from the inner side of the thighs, the perineum, and the penis, and is common to the two testicles. It is a symmetrical bag, and the two halves are marked off from each other by a middle line or elevation of the skin, called the Raphe, which begins in the perineum at the anus, and, winding around the scrotum, is continued along the under surface of the penis to the prepuce.

The skin of the scrotum is thin, and darker than elsewhere, but has a thick, strong epidermis; it has many sebaceous follicles in it, and is sparingly furnished with hair. It is very extensible, as manifested in fatigue, and by hydrocele; and may be contracted again so as to draw the testicles close under the pubes, though for the latter power it principally depends upon the subjacent coat. Its surface is covered with wrinkles, for the most part transverse, and ending at the raphe: they are effaced during its great distensions in hernia and in dropsy, and then it has a smooth shining surface.

The *Dartos* is placed within the scrotum, and forms two distinct sacs or tunics, one for each testicle. It arises from the inferior margins of the crura of the ischia and of the pubes, and lines the scrotum till it reaches the raphe; it is then reflected upwards to form the partition between the testicles (*septum scroti*), and terminates at the corpus spongiosum urethræ. This membrane, according to the observations of MM. Chaussier, Lobstein, and Breschet,[1] does not exist in the scrotum till the descent of the testicle, and then appears to be an expansion of the gubernaculum testis.

It receives a considerable number of blood-vessels, which, owing to the thinness of the skin, may be seen in the living body, ramifying through its substance; its general appearance is, therefore, reddish. It is destitute of fat, and consists in long fibres of elastic tissue much matted together, and passing in every direction: they are easily separated by distension with air or water, and by slight maceration. Its powers of contraction are exceedingly well marked upon the application of cold to the scrotum, or after discharging the water of a large hydrocele, from which cause it has been considered by many anatomists as muscular: the only distinct evidence, however, which I have met with of a resemblance to the latter has been found generally on its posterior face, near the perineum.[2] From its equivocal character, J. F. Meckel has very ingeniously suggested that it forms the transition from cellular to muscular tissue, and that there exists between it and other muscles the same relation that there is between the muscles of the superior and of the inferior orders of animals. Among the latter, the fibrous structure is indistinctly marked, and is masked by gelatine, an element of the cellular tissue; which envelops and conceals the fibrine, an element of the muscular tissue. Mr. Bowman has detected in it the plain muscular fibre.

The fibres of the cremaster muscle, which are next in order, form a

[1] Dictionnaire des Sciences Méd. tome viii.

[2] I have dissected one subject (January, 1830), where the fibres were evidently muscular, though interwoven.

very imperfect covering to the testicle, and belong rather to the spermatic chord: what remains to be said concerning them will be more properly introduced into the account of the latter. The cellular substance that connects the dartos and the cremaster with the tunica vaginalis forms a compact and perfect lamina, sometimes spoken of as the *Tunica Vaginalis Communis Testis.* There is one for each testicle, which it surrounds entirely, as well as its chord, and connects the chord to the circumference of the external abdominal ring, as stated in the account of the latter. At its upper end it is continuous with the cellular substance (*fascia transversalis*) that unites the peritoneum to the parietes of the abdomen, as may be proved by inflating it, when the air will penetrate accordingly through the abdominal canal. The origin of this tunica vaginalis communis may be considered then as identical with the spermatic fascia.

The Peritestis, or Tunica Vaginalis, was originally a process of peritoneum, communicating with the cavity of the latter through the abdominal canal; but in the adult it appears as a complete and distinct sac. As it is very rigidly comparable to a double night-cap drawn over the head, we accordingly find that the testicle, along with the epididymis, is pushed into it from behind. That portion of the tunica vaginalis which is in contact with the testicle, or rather with the tunica albuginea, adheres so closely that it cannot be separated, except very partially and in shreds; but it may be detached easily from the epididymis, with the convolutions of which it is in immediate contact. This sac is longer and larger than the testicle itself, from which cause it ascends for several lines above the superior end of the gland, and the free part hangs loosely about it. Its cavity may, with but little force, be injected so as to hold an ounce or two of fluid.

This membrane is smooth and polished on the surface forming its cavity, and contains a small quantity of serous halitus, which allows the opposed surfaces to glide freely upon one another. Its exterior connection with the dartos is so slight that it may be withdrawn without dissection, with the exception of an adhesion at the lower end of the testis arising from the remains of the gubernaculum: in such case, however, it still continues to be invested by the tunica vaginalis communis, from which it can only be removed by a special dissection.

The *Tunica Albuginea* is the proper coat of the testicle; is in immediate contact with its glandular structure, and serves to maintain its shape, as well as to protect it from pressure. From its internal surface proceed many membranous, horizontal fibres, which form partial partitions of its cavity (*septulæ testis*) and incline towards its posterior part, where they terminate in a longitudinal projection, called Corpus Highmorianum. The latter is of a prismatic shape, somewhat broader above than below, and is of but little consequence, except that it was once erroneously supposed to be a sinus, into which the seminiferous tubes discharge. Sir Astley Cooper proposes to call this the mediastinum testis, and considers the Corpus Highmorianum as being formed by an inflection of the tunica albuginea. The Septulæ Testis, he asserts, really envelop the seminiferous tubes, by forming bags which support, confine,

protect, and nourish the tubular structure of the testis.[1] The albuginea is perforated by several foramina along its posterior margin, where there is a deficiency of tunica vaginalis, for the passing of excretory ducts and blood-vessels.

This membrane is a dense, strong, white, fibrous tissue, resembling in structure the tunica sclerotica of the eye, and the dura mater of the brain. Sir A. Cooper considers it as consisting of two layers which can be readily separated by dissection, excepting in front; the outer layer is more fibrous, while the internal, which he calls Tunica Vasculosa, has the spermatic arteries and veins ramifying upon it. They are rendered very distinct from each other by a minute injection.[2]

Of the Minute Structure of the Testicle.[3]—The glandular portion of the testicle consists in a congeries of zigzag tubes (*tubuli seminiferi*) which are collected into lobules. One, two, or more tubes constitute a lobule, and the lobules are kept apart by the septulæ testis. These lobules are of a conoidal shape, having their points towards the posterior middle line of the Testis and their bases rounded; they diverge from the corpus Highmorianum, so as to fill up the cavity of the tunica albuginea. The entire number of tubes amounts to 300, according to Dr. Munro; with an aggregate length of 5208 feet, and the diameter of each one does not exceed one-two-hundredth part of an inch, and its length is somewhat short of seventeen and a-half feet. Their number is, according to Krause, from 404 to 484. Lauth has stated the number of tubes to be 840, and the length of each to be about twenty-seven inches, which corresponds nearer with my own observations, and makes an aggregate length of about one-third of that represented by Dr. Munro. These tubes form convolutions or hanks, the threads of which are serpentine, very much like the thread of a ravelled stocking, and are held together by a delicate cellular substance easily softened by maceration. Each tube forms of itself a hank, which is kept distinct from the adjacent ones by the septulæ or processes of the albuginea, and may be easily picked out from them. Their extreme tenuity and delicacy of structure cause them, when well macerated, drawn out with a pin, and then suspended in water, to resemble a tangled skein of fine silk.

The tubuli seminiferi finally terminate in some straight tubes, called the Vasa Recta, which unite near the middle back part of the testicle in a somewhat complicated arrangement, obtaining the name of the Rete Vasculosum Testis. This Rete Vasculosum is placed in the Corpus Highmorianum, and from it there proceed from twelve to eighteen ducts (*vasa efferentia*) which go upwards and backwards through the corpus Highmorianum, and the tunica albuginea. Each of these vasa efferentia is then convoluted upon itself into a conical body, called Conus Vasculosus, which presents its base backwards. Each conus, at its base, has its tube entering successively into the tube of which the Epididymis is formed.

According to Lauth, the number of vasa efferentia varies, in different subjects, from nine to thirty, and when the entire length of each

[1] Observations, &c. on the Testis, p. 14, London, 1830.
[2] Ibid.
[3] Hunter, Med. Comment. p. 1, 1777. Albinus, Acad. Annot. lib. ii. Loder, Tab. Anat. Ruysch, Thes. Anat. iv. Haller, Op. Min. tom. ii. Alex. Munro de Testibus, Ed. 1755.

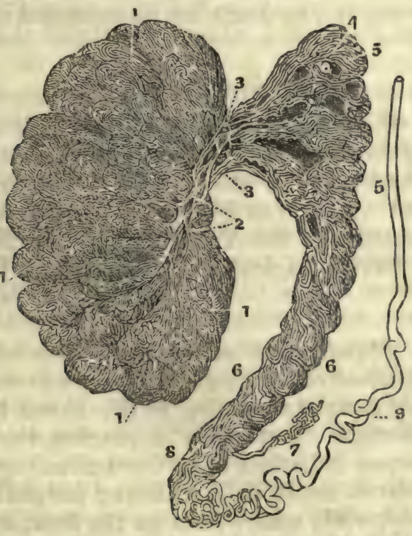
one is extended it measures eight inches; of course, including the conus vasculosus.

The anterior ends of the tubuli seminiferi would seem, from the observations of Lauth and Krause,[1] to have different modes of terminating; some end abruptly, others by a loop, and others by anastomosis with contiguous tubes. These anastomoses, according to Lauth, are most frequent towards the base of the lobules, and occur there about every three inches.

At the other end of the seminal tubes, several unite into one, to form a vas rectum, of which there are at least twenty, and with a diameter larger than the tubuli seminiferi. The vasa recta are a line or two long, they then are reduced into from seven to thirteen trunks, forming what is called the Rete Vasculosum Testis, which is distinguished by the waving course of its trunks, and by their frequent anastomoses with each other.

Notwithstanding the extreme tenuity of these several arrangements in the excretory ducts of the testicle, they may be entirely filled with quicksilver from the vas deferens; but the task is one of great difficulty, and rarely succeeds.

Fig. 196.



The Testis minutely injected with Mercury.—1, 1. Lobules of the tubuli seminiferi. 2. Rete testis. 3. Vasa efferentia. 4, 5. Coni vasculosi forming the globus major. 6. The epididymis. 7. Vasculum aberrans. 8. Globus minor. 9. Vas deferens.

The *Epididymis* is the prismatic arch which rests vertically on the back of the testicle, and adheres to it by the reflection of the tunica vaginalis. It is enlarged at both ends, the upper of which, being formed by the Coni Vasculosi, is called the Globus Major, and the lower enlargement is the Globus Minor. It is made of a single con-

[1] Müller, loc. cit. p. 499.

voluted tube, of the fourth of a line in diameter. After this tube has got to the lower end of the globus minor, it becomes less convoluted, enlarges, turns upwards on the inner side of the epididymis, and obtains the name of Vas Deferens, which, before it reaches the top of the epididymis, has become perfectly straight, or almost so.

The average length of the canal of the Epididymis is about twenty-one feet, and the coni vasculosi discharge into it at intervals of three inches and a-quarter.[1]

There is a blind duct (*vasculum aberrans*) which is found attached to the epididymis. The base of it is upwards, and the other end discharges into the lower end of the canal of the epididymis, where the latter makes its turn into the vas deferens. Its length, when stretched out, varies from one and a half to fourteen inches. It has very much the appearance of an obstructed lymphatic, and may possibly be of that kind, as a very free communication exists between the seminal canals and the lymphatic system. Sometimes there are several. The use is unknown.

The tubuli seminiferi form a system of closed tubes, with the exception of the posterior end, which discharges into the Rete Testis. Their diameter is about fifteen times greater than that of the arteries ramifying upon them. Their whole internal surface probably executes the seminal secretion, and no doubt has its epithelial cells for this office.

Of the Spermatic Chord.

The Spermatic Chord is a fasciculus of about half an inch in diameter, which may be felt very readily through the skin of the scrotum, passing from the upper end of the testicle to the external abdominal ring. It is formed by the Vas Deferens; the Spermatic Artery and Veins; the Lymphatics of the Testicle; and the Nerves; all being covered in by the Tunica Vaginalis Communis, and by the Cremaster Muscle.

The *Cremaster Muscle*, also called the tunica elythroides,[2] being derived from the internal oblique and the transverse muscle of the abdomen,[3] forms a very complete envelop to the chord from the abdominal ring to the testicle. But when it reaches the latter, its fibres spread out and become indistinct upon the tunica vaginalis communis, as they there consist in small, pale, scattered fasciculi; many of which terminate insensibly, while others form on the front of the tunica vaginalis, loops, having their convexities downwards. This muscle draws the testicle upwards, an action very different from the corrugation of the scrotum.

The *Vas Deferens*, or the proper excretory duct of the testicle, is a white tube of about a line and a half in diameter, and has a cartilaginous feel. Its parietes are thick, as its cavity will not receive a body larger than a bristle, without being put upon the stretch. It traverses a long space, and in doing so, first passes at the back of the chord

[1] Lauth, see Müller. [2] Ελυτρον, a sheath. [3] See Abdominal Muscles.

from its commencement to the internal abdominal ring; having reached the latter, it then abandons the spermatic artery and vein, and dipping into the pelvis, by the side of the bladder, goes between the lower fundus of the latter and the ureter. It then converges towards its fellow, along the under extremity of the bladder, at the inner margin of the vesicula seminalis of the same side, and finally terminates in the urethra near the neck of the bladder, by forming the Ductus Ejaculatorius with the assistance of the duct of the adjoining vesicula seminalis. About two and a half inches from its termination, it enlarges and becomes somewhat tortuous.

This duct consists of two coats: the external one is hard, compact, and occasionally fibres are seen in it; but its structure is not very evident, and is peculiar. The internal is a mucous membrane.

The Spermatic Artery is a line or less in diameter at its origin from the aorta below the emulgent artery, but augments in descending so as to counteract friction in the course of its great length. It supplies the testis and the epididymis.

The Spermatic Vein returns the blood from the testicle and the epididymis. It forms a plexus both below and above the inguinal canal in its ascent. That on the right discharges into the ascending vena cava, while the left empties into the left emulgent vein.

For further description of the remaining portions of the chord, see Spermatic Artery, Vein, Lymphatics, and Plexus of Nerves.

The Testicles undergo a remarkable change in their position, from the earliest development of their rudiments to the perfect fœtal state. They are not formed in the scrotum, but in the abdomen just below the kidneys; from which position they are gradually transferred. About the middle of the third month of gestation, they are two lines long, and placed behind the peritoneum, to which they adhere. The vas deferens then, instead of rising up on the side of the epididymis, goes straight down into the pelvis. At this period may be seen the gubernaculum testis, discovered by J. Hunter,[1] which becomes more distinct in a few weeks afterwards, and assumes a triangular appearance. This gubernaculum has the office of drawing the testicle down into the scrotum; its point commences in the upper part of the latter, somewhat below the external abdominal ring; it passes through the abdominal canal, ascends upon the iliacus internus muscle, and is attached by its base to the inferior end of the testicle. In front of the gubernaculum, a process, or small pouch of peritoneum, passes through the abdominal canal to the upper part of the scrotum. By the contraction of the gubernaculum, the testicle is brought, about the seventh or eighth month, into the scrotum, by descending behind the pouch. At this period there is a firm adhesion between the tunica albuginea and the peritoneal coat of the testicle, *i. e.* the ultimate tunica vaginalis. The lower end of the pouch, at which the testicle is finally arrested, is a part of the tunica vaginalis testis.

As soon as the testicle has reached the scrotum, the neck of the pouch has a tendency to close and to become obliterated, which is com-

[1] Med. Comment. Lond. 1777.

monly accomplished at the period of birth; yet it sometimes remains open for a longer time and becomes the occasion of congenital hernia. Very generally at birth, the orifice of the pouch will receive the end of a probe to the depth of a line or two; but all below is perfectly closed, and has its structure so condensed and altered that no one, from a view of it alone, would suppose that the cavity of the tunica vaginalis had ever communicated with that of the peritoneum.[1]

SECT. II.—OF THE URETHRAL GLANDS AND APPARATUS.

The Prostate Gland (*glandula parastata*) is a body about the size and form of a horse chestnut, fixed on the neck of the bladder, and penetrated by the urethra, which traverses it much nearer its superior than its inferior surface. The base of it is turned backwards, and the point forwards; its inferior surface rests upon the rectum; it is rendered concave by that circumstance, and its sides, in the distensions of this organ by feces, are overlapped by it. The Prostate has, posteriorly, a notch in its centre, which divides it into two lateral lobes, and by raising the Vesiculæ Seminales, we see where their excretory ducts penetrate the gland, and separate from the body of it, the little tubercle, to which Sir Everard Home[2] has particularly called the attention of the profession, and considered as a third lobe. The third lobe is frequently the seat of disease and tumefaction.

On the under surface of the canal formed in the prostate, by the urethra, is the oblong elevation called the Verumontanum, or Caput Gallinaginis. It commences a little in front of the uvula vesicæ, and, being broader and higher behind, comes to a point very gradually before. Very superficial folds of the lining membrane, some three or four in number, radiate from the anterior end of the caput to the anterior end of the membranous portion of the urethra. The use of the Caput Gallinaginis, as already intimated, is probably to plug the orifice of the urethra at the neck of the bladder, at the moment of ejecting the semen: it being drawn backwards to that effect by the muscle of the vesical triangle.

In the fore part of the caput gallinaginis, Morgagni found, in twelve out of fifteen cases, a cleft or pouch with its orifice opening forward. It makes a cul-de-sac, from three to five lines deep, one line in diameter at its orifice and two at its fundus. By Huschke, it is considered as a rudimentary uterus in the male, and is therefore called by him the Utriculus Prostaticus, and by Weber the Vesica Prostatica. In its front part are the orifices of the ductus ejaculatorii. I have lately met with a case of diseased prostate where it was four lines in depth and

[1] The explanations and anatomy of this process have been treated at large in the following works:—

Girardi, Tabul. II. adj. Septemd. Tab. Santorini.

J. Hunter, Observations on Certain Parts of the Animal Economy. W. Hunter, Med. Commentaries.

Edwardi Standifort, Opusc. Anat.

Wrisberg. Comment. Medic. Physiolog. &c.

[2] Diseases of Prostate.

received a probe of large size. A similar case has been detailed by Prof. Renke.[1]

The prostate consists in a condensed, white, extensible, though easily lacerated fibrous cellular tissue, within which are placed numerous glands, which discharge by twenty or thirty ducts or more (according to Loder, from thirty-two to forty-four), passing obliquely forwards and terminating in the urethra, at the sides of the urethral crest, or caput gallinaginis. It is an aggregation of smaller glands, like the mamma or any other composite gland; the principal ducts are therefore formed by the convergence of branches in successive junction. The fluid secreted is thick, ropy, white, and semi-transparent, in a healthy state. The ducts of the third lobe penetrate the coats of the bladder, behind the caput gallinaginis.

The prostate is surrounded by a fibrous capsule, to be described.

The Seminal Vesicles (*vesiculæ seminales*) are two convoluted tubes, one on each side, two inches in length, placed on the lower fundus of the bladder, between it and the rectum, and behind the prostate gland. At their anterior extremities they approach very nearly to each other, being only separated by the intervention of the vasa deferentia. They are fixed to the bladder, and surrounded by a thick mass of adipose and cellular matter, with many blood-vessels, principally veins, passing through it.

When inflated and dried, they present the semblance of cells, but are, in fact, long tubes; which, being convoluted, are reduced to the

Fig. 197.

A section of the Union of the Vas Deferens and Vesicula Seminalis, so as to show their Cavities.—1, 1. Vas deferens with thick parietes and narrow cavity. 2, 2. Portion of the same where the cavity is enlarged. 3, 3. The extremity of the vas deferens from each side where it joins the duct of the vesicula seminalis to make the ductus ejaculatorius. 4, 4. Vesiculæ seminales distended with air and dried. 5, 5. Arteries to the vesiculæ. 6. Portion of the peritoneum covering the posterior part of the vesiculæ. 7. Ejaculatory ducts.

apparent dimensions mentioned. When dissected and stretched out, they are four or five inches long by three lines in diameter.

There are also on each side of the long tube several pouches which increase the number of cells. The convolutions are preserved by the intermediate cellular tissue. These bodies consist of two coats: an external, which is a condensed fibro-cellular substance, and an internal,

[1] See Med.-Chir. Review, Jan. 1848, p. 271.

which is mucous, being a continuation of the lining membrane of the urethra. The excretory duct of each seminal vesicle is about a line and a half long, when it joins in the substance of the prostate with the vas deferens of the same side. A common canal (*ductus ejaculatorius*) is thus formed, which runs parallel with its fellow, below the urethra.

The Ductus Ejaculatorius is about eight or ten lines long, and opens by an oblong orifice, on the anterior margin of the Caput Gallinaginis; it is larger behind than before, which gives it a conical shape, and allows fluids injected to pass freely from the vas deferens to the vesicula seminalis, and the reverse.

The vesiculæ are commonly filled by a drab-colored thick fluid, supposed to be a mixture of the semen, with their own proper secretion, though, of this, Mr. Hunter[1] doubted, inasmuch as he found them equally well filled in cases where the testicle of the corresponding side had been lost, and therefore he concluded that they were not indebted to the secretion of the testicle for their contents. The discovery, latterly, of spermatic animalcules in the fluid contained after death in the vesiculæ is considered as proof sufficient of their being reservoirs of the male semen along with their own secretion, as these animalcules were most probably conveyed there along with the semen.[2]

Of the Glands of Couper.—These glands are also intended for a secretion into the canal of the urethra. They are two in number, one on each side, and are situated in advance of the prostate, between the laminæ of the triangular ligament, at the point where the bulb of the urethra adheres to it. Commonly, they are about the size of a garden pea, but not unfrequently much smaller, and, in some instances, cannot be found at all, which induced Hiester to declare that he had searched for them fruitlessly. They are yellowish, hard, consist of several lobules united together, and are composed of cellular crypts like the prostate gland. The duct from these crypts by successive union, form for each gland an excretory duct that receives readily a bristle, and passes obliquely forwards, between the corpus spongiosum and the canal of the urethra, to terminate in an oblique orifice in the latter, about an inch distant from the gland.

One or more glands, of the same description, and discovered by Littre, are occasionally found just in front of Couper's. They also discharge their secretion into the adjacent part of the urethra. In my own dissections I have not met with them. Both Couper's and Littre's glands are in texture so like the prostate, that they are probably merely accessory glands to it.

SECT. III.—OF THE PENIS.

The Penis (*membrum virile, mentula*), from performing the two offices, one of which is the conducting of urine from the bladder, and the other the intromittence of semen into the female, has a peculiarity of struc-

[1] Observations on the Animal Economy.

[2] In a dissection executed at the University by Dr. Joseph Togno, a muscle was found on the inferior surface of the seminal vesicles arising from the prostate gland, and inserted into them. This is said to be a common arrangement in some animals.

ture, which admits of collapse and of distension. Its shape is almost cylindrical, but terminating in front by an obtusely pointed extremity, named Glans. It adheres by its posterior end or root to the bones of the pelvis, at and below the symphysis pubis.

It is formed by common integuments, by condensed cellular tissue, by the Corpus Cavernosum, and by the Corpus Spongiosum.

The skin on the penis is more thin and delicate than it is on most other parts of the body, and is furnished with a considerable number of sebaceous follicles or glands about the root of the organ, with hairs growing from the centre of them. This same skin, in passing to the abdomen over the pubes, is somewhat elevated by a subjacent deposit of fat and cellular matter, causing an appearance corresponding with the mons veneris of the female; and is also generally thickly covered with short curly hair, which, as the individual advances in life, proceeds in a pointed direction to the umbilicus. The skin of the penis is connected to the organ by a loose filamentous cellular substance, so that it slides readily backwards and forwards, and by its elasticity is well suited to the varying states of distension and collapse. At the anterior extremity it is thrown into a duplicature or fold, the prepuce (*præputium*); the internal lamina of which being fixed circularly to the penis, some distance back from the point, permits a considerable por-

Fig. 198.

A vertical section of the Penis and Urethra.—1. Glans penis. 2. Orifice of the urethra. 3. Fossa navicularis. 4. Corpus spongiosum urethræ. 5. Anterior portion of the septum pectiniforme. 6. Its posterior portion. 7. Bulbous portion of the urethra. 8. Bulb of the corpus spongiosum. 9. Posterior end of the corpus cavernosum.

tion of that extremity of the penis, called the Glans or head, to project when the prepuce is drawn back. The under middle part of the prepuce is attached to the extremity of the glans by a vertical longitu-

dinal duplicature, called the Frænum, which extends to the orifice of the urethra.

The skin does not actually stop at the circumference of the glans, but is continued smoothly over it, modified, however, so much in its structure as to be much more soft, delicate, vascular, and sentient. It adheres very closely to the glans so as to admit of little or no sliding, and its cuticle there is a thin epithelium, readily separated by maceration. The projecting circular and oblique rim of the glans, behind which the skin becomes firmly joined to the penis, is called the Crown (*corona glandis*). The contracted portion, behind the corona, is the Neck (*collum*). On the surface of the neck and the posterior face of the corona, the skin is furnished with an abundance of small glandular masses or follicles (*glandulæ odoriferæ Tysoni*), which secrete the thick white sebaceous matter (*smegma præputii*), that accumulates when personal cleanliness is not attended to.

The penis, in addition to other modes of attachment to the bones of the pelvis, is fixed by the Ligamentum Suspensorium. The latter is a triangular vertical fibrous lamina, which proceeds downwards from the symphysis pubis to the dorsum of the penis; and, according to Mr. Colles, envelops this organ to the glans, forming its cellular coat, and being continued into the fascia superficialis abdominis. This cellular coat is found sometimes in no small degree condensed in its texture and fibrous, so that it becomes a sort of fascia. Posteriorly, it is lost insensibly on the fascia of the thighs, covering the adductor muscles. At its origin it is occasionally furnished with muscular fibres; one strongly marked instance of which has been presented to me in my own dissections.

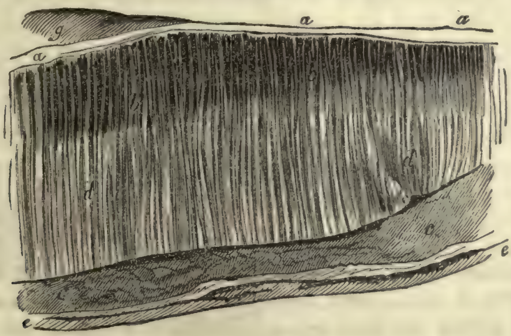
The Corpus Cavernosum of the penis forms by much the most considerable portion of the whole organ. Externally, it is a white fibrous membrane, of a dense structure, enjoying extensibility and an extreme degree of contractility. This coat of the penis is occasionally called its Elastic ligament (*involucrum*). Its external fibres pass, for the most part, longitudinally, except about the root, where they are blended with the periosteum of the bone, and with the tendons of the muscles. It arises by two conical crura, swollen at their base (the *Bulbi cavernosi* of Kobelt), from the internal face of the crura of the pubes and ischia to within a little distance of the anterior part of the tuber ischii. At the lower part of the symphysis pubis these crura join and form a body; which, when stripped of its connections, resembles two cylinders united, alongside of each other, and which terminate in common, anteriorly, by a truncated cone, covered obliquely by the glans. At the posterior part of the corpus cavernosum, in its middle, there is a septum, almost complete, also of the same elastic substance, which separates the two halves from each other; but, anteriorly, this septum is more imperfect, having an arrangement like the teeth of a comb, whence the term Septum Pectiniforme has been given it. This septum has its points upwards, and is continued at its margins into a layer of circular fibres, constituting the internal coat of the corpus cavernosum. In this arrangement into external longitudinal and internal circular fibres, we

see a renewal of the same mechanism which marks the hollow viscera. It is commonly not noticed by anatomists.

In the middle of the corpus cavernosum, above, is a longitudinal depression for lodging the veins of the penis, and, in the same manner, there is another below, for the corpus spongiosum urethræ. The involucrum of the corpus cavernosum is formed of white fibrous tissue, and of yellow or elastic; the latter predominates much.

The cavity of this membrane is filled by a spongy tissue, that arises from its internal face, and is formed of filaments and little laminæ (*trabeculæ*) of the white and of the yellow or elastic fibrous tissue; they, by crossing each other, make a multitude of cells, which have a perfectly free communication with one another, and generally are somewhat occupied by blood. A fine injection through the artery of the corpus cavernosum will fill these cells and return through the veins; from which cause the cells may be considered as intermediate to the two orders of vessels. This opinion is the more probable from the cells being lined by a thin membrane like the internal one of the veins, and which is easily seen near the septum by tearing the spongy part from it.

Fig. 199.



Transverse section of Penis, exhibiting the lateral interior view of the Left Corpus Cavernosum, which has been slit up longitudinally at the dorsum penis and pulled open.—*a*, *a*. Dorsum of involucrum penis. *b*, *b*. Septum pectiniforme, with the points of the dentate processes upwards. *c*. *c*. Trabecular tissue detached from involucrum and rolled into a cylindrical mass. *d*, *d*. Circular interior fibres of the involucrum inflected in their course so as to form the septum pectiniforme. *e*, *e*. Cut edge of involucrum drawn down from *a*, *a*, with which it corresponds, and thereby shows the whole interior circuit of the involucrum of the left side. *f*. Posterior end of section of penis; the other end exhibits above a very limited portion of the glans.

The veins may not only be filled in that way, but if a pipe be fixed into a crus, the injecting matter passed through it will fill all the veins of the corpus cavernosum and return exactly as if it had been first thrown through the arteries; a fact which proves adequately the free lateral communication of the veins.

The internal cellular structure of the corpus cavernosum is then probably formed, almost exclusively, by the internal coat of the dilated veins, partially sustained by the above filamentous and laminated bands, for the purpose of strengthening the arrangement. The adhesion of this structure at large to the corpus cavernosum is much weaker than one may suppose, as it is very easy to peel or roll it off almost without

dissection, thus leaving the elastic coat of the corpus cavernosum perfectly free.

The Corpus Spongiosum Urethræ extends from ten or twelve lines behind the junction of the crura of the corpus cavernosum to the anterior extremity of the penis. Externally, it has a coat (*involucrum*) resembling that of the corpus cavernosum, except that it is thinner. In its centre is the canal for the passing of urine. The corpus spongiosum is not of equal diameter in its whole course, for its commencement in the perineum, where it is pendulous, is enlarged into what is termed the Bulb; from this it diminishes gradually to the anterior end, where it is again enlarged into the glans penis. In some subjects the bulb has a very evident bilateral division resembling two lobes, with a partial septum within. Between the urethral canal and the coat is a spongy structure, much finer than that of the corpus cavernosum, and though the cells communicate freely, still they have the appearance of convoluted veins. This structure is very much a repetition of the corpus cavernosum, but the venous cells are of a more cylindrical shape, and they cannot be detached so readily from the involucrum.

Müller[1] has made the assertion that there are two modes of arterial termination in the erectile or cellular structure of the penis, one by

Fig. 200.

direct connection with the incipient ramuscles of the veins, and the other, by tufts of cœca bent backwards on themselves, as here represented, and which he has named Helicine arteries (*arter. helicinæ*). Projecting as they do into the venous cells, he declares that, though no openings from them can be discovered, yet the latter exist so as to fill the cells in erection. These singular arteries are found principally in the back part of the corpus cavernosum and spongiosum, and are seen, after a minute size injection of the arteries of the penis, by washing the size from the cells, when the cells have been filled.[2]

[1] Elem. Physiol. vol. i. p. 252, Lond. 1840.

[2] Prof. Valentin (Müller's Archiv. 1838, p. 182) denies the existence of the arteriæ helicinæ. According to his observation, all the branches of the arteries of the corpus cavernosum, after forming numerous anastomoses, terminate in the large veins of the penis. The small arteries run in the centre of the bundles of fibres which lie between the veins; and when these bundles of fibres, or band-like septa, are cut or torn across, they, together with the arterial twigs within them, contract and assume a contorted, sometimes spiral figure. In this state they form the so called arteriæ helicinæ. The fibrous bands which pass inwards between the anastomosing veins from the tunic of the corpus cavernosum, consist, according to Prof. Valentin, of tendinous tissue, and give attachment to muscular fibres, similar to those of the intestinal canal, which pass from them to the parietes of the veins. M. Valentin supposes erection to be in a great measure due to the active dilatation of the veins by these muscular fibres; but the characters on which he founds his belief that the fibres in question are muscular are not conclusive.

The Urethra is a mucous canal, whose length varies according to the degree of distension in the penis, and extends from the neck of the bladder to the extremity of the glans. It is difficult to assign a fixed length to the canal of the urethra, owing to the variable size of the penis in different persons, and in the same individual, depending upon his general vigor and also period of life. The measurements of Professor Pancoast[1] in the black and mulatto, show an average of about seven inches from the neck of the bladder to the end of the urethra in the unstretched state, and about an inch more in stretching the organ moderately. It is, however, well known that the sexual organs of the black are larger, both male and female, than of the white.

The first part of this canal which traverses the prostate gland is from fifteen to eighteen lines in length, and is called the Prostatic Portion; it is well supported by this body, although its own sides are very thin. On its inferior surface is the doubling which constitutes the Verumontanum or Caput Gallinaginis. On either side of the caput gallinaginis the canal of the urethra is depressed into something like an oblong cul-de-sac or narrow trench, where are to be found the lacunæ of the prostate gland.

Between the Prostate and the Bulb is the membranous part of the urethra, about eight or ten lines long; it is unprotected, except by a soft covering, which seems in some measure to be a mixture of gelatinous matter and muscular fibre. The former was considered by Littre as a glandular body which secreted a viscid humor into the interior of the canal; the latter, probably, is the part described by Winslow as the inferior prostatic muscle, which he asserted to arise on each side of the membranous part of the urethra, and to be inserted into the corresponding branch of the pubes near the symphysis. My own opinion upon treating it carefully in alcohol is that it is a continuation in a softer state of the prostate gland, and corresponds with the urethra in the female. The membranous part of the urethra does not get into the end of the bulb, but penetrates it from above, half an inch or more occasionally, from its extremity, just below the junction of the crura of the corpus cavernosum.

The canal varies in its diameters: at its commencement, which is synonymous with the neck of the bladder, it is large; it then contracts at the back of the caput gallinaginis, and immediately enlarges in the fore part of the prostate, at the sides of the caput. The membranous part is small; the canal then enlarges in the bulb. In the body of the penis the canal is successively diminished, till it comes almost to the glans, when it is so remarkably enlarged again as to get the name of Fossa Navicularis; it terminates, finally, by a short vertical slit at the extremity of the glans.

The canal of the urethra is formed of a very thin mucous membrane. On the outside of it is a dense filamentous cellular substance which has no disposition to secrete fat, and is so like the third coat of the hollow viscera, that it might be called the *tunica propria*, also possessing much extensibility, contractility, and elasticity. The mucous membrane has great vascularity, and its veins are so superficial that they frequently

[1] Wistar's Anat. 8th edit. vol. ii. p. 170.

bleed freely upon the introduction of an instrument into the bladder; it is also very sensitive. The cellular coat on its outside, whereby it adheres to the spongy structure, contracts sometimes in such a manner that circular fasciculated ridges simulating the presence of circular muscular fibres, are seen shining through the mucous coat, though, when the mucous coat is peeled off, this arrangement disappears.

In the whole length of the canal there are two folds or lines, one above, and the other below; and in the membranous and spongy portions, excepting the fossa navicularis, longitudinal folds of the mucous membrane also exist, which are effaced by distension. The fossa navicularis sometimes exhibits in the contracted penis, hardened in spirits of wine, very superficial folds of the mucous membrane almost transverse, in the narrow depressions between which we see the orifices of very fine mucous follicles.

In the upper part of the canal there are a great many mucous lacunæ or crypts;[1] Loder has marked about sixty-five: there is one particularly large (*lacuna magna*) in the upper surface of the fossa navicularis, which may stop the point of a bougie, and be mistaken for stricture.[2]

Mr. Shaw has described a set of vessels immediately on the outside of the internal membrane of the urethra, which, when empty, are very similar in appearance to muscular fibres. He says, he has discovered that these vessels form an internal spongy body, which passes down to the membranous part of the urethra, and forms even a small bulb there. Kobelt has given to it the name of *colliculus bulbi*, and says that it goes back along the urethra surrounding it to the neck of the bladder.[3] His preparation, being a quicksilver injection of the part, is certainly a very satisfactory demonstration of its existence; yet in my own observations, where the blowpipe had been resorted to, it has rather appeared to me to be the cellular membrane connecting the canal of the urethra with the corpus spongiosum.

The urethra is curved, and receives in its course the ductus ejaculatorii, the excretory ducts of Couper's glands, and the mucous lacunæ of its own internal membrane.

The arteries of the penis come from the internal pudic: they are the art. cavernosa profunda, the urethro-bulbaris, and the superficialis dorsi penis. The veins for the most part emerge, concealed between the corpus cavernosum and spongiosum, and thus assemble in their respective channels; some of the veins follow the course of the arteries, and others collect into the two venæ dorsales penis, which unite into one under the inferior pubic ligament, and thus finally end in the prostatic plexus.

The nerves come from the Superior and Inferior Pudendal.

[1] Tabul. Anat.

[2] Sir Everard Home formerly communicated to the Royal Society a highly interesting paper on the structure of the lining membrane of the urethra. From his microscopical observations he was induced to think that it is muscular.

[3] Med.-Chir. Trans. vol. x.

SECT. IV.—OF THE MUSCLES AND FASCIÆ OF THE PERINEUM.

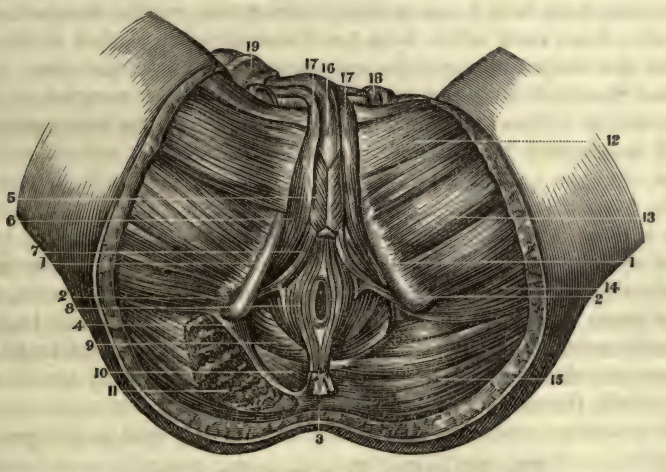
Perineal Fascia.

The Perineal Fascia (*fascia perinæi superficialis*) is placed just beneath the skin of the perineum, and covers the muscles. It is spread over nearly all the space between the anus and the posterior margin of the scrotum, and between the rami of the pubes and the ischia on each side: it is very firmly fixed to these bones, and is gradually blended with the cellular substance of the posterior part of the scrotum. This fascia is rather thin, but, in case of a rupture of the posterior part of the urethra, prevents the urine from showing itself in the perineum, and drives it into the cellular structure of the scrotum. In abscesses of the perineum, it also prevents the fluctuation from being very evident.

The Musculus Erector Penis

Is so situated as to cover the whole of the crus of the penis which is not in contact with the bony margin of the pelvis. It arises, therefore, tendinous and fleshy, from the anterior part of the tuber ischii; its fleshy fibres adhere to the internal and external margins of the ramus

Fig. 201.



A view of the Muscles of the Perineum of the Male.—1. Ascending ramus of the ischium. 2. Tuber ischii. 3. Posterior face of the coccyx. 4. Portion of the great sacro-sciatic ligament. 5. Musculus accelerator urinæ. 6. Erector penis muscle. 7. Transversus perinei. 8. Sphincter ani. 9. Levator ani. 10. Musculus coccygeus. 11. Section of the gluteus magnus. 12. Adductor longus. 13. Adductor brevis. 14. Adductor magnus. 15. Extremity of the gluteus magnus. 16. The urethra. 17. Corpora cavernosa turned up. 18. Spermatic cord turned up. 19. Free extremity of the penis with its integuments.

of the ischium, and of the pubes, and proceed upwards: just before the union of the crura of the penis, they end in a flat tendon which is lost on the side of the corpus cavernosum of the penis.[1]

[1] The late Dr. Lawrence informed me that he had frequently found muscular fibres between the bone and the crus penis.

Its use is not well understood. The probability is that it acts as a compressor upon the dilated base of the crus penis when the latter is erect, and by compressing it assists in shoving the blood forwards.

The Musculus Accelerator Urinæ

Lies on the bulb and back part of the corpus spongiosum urethræ. It is a thin muscle, consisting of oblique fibres.

It arises by a pointed production from the side of the body of the penis; its origin is continued obliquely across the inferior surface of the crus penis, where the latter begins to form the body of the penis. It arises, also, for an inch from the inner side of the ramus of the pubes, between the crus penis and the triangular ligament of the urethra. The muscles of the opposite sides are inserted into one another by a white line, which marks the middle of the bulb of the urethra; and by a point, into the anterior extremity of the sphincter ani, where they are joined by the transversi perinei.

In order to see the origin of these muscles very distinctly, separate them from each other in the middle line, and dissect them from the corpus spongiosum. Cut transversely through the corpus spongiosum about three inches before the triangular ligament, and dissect it clearly from the corpus cavernosum, turning it downwards so that it may hang by the membranous part of the urethra. By putting the two acceleratores on the stretch, it will be seen that, besides the origins mentioned, they arise, also, from each other by a tendinous membrane that is interposed between the corpus spongiosum and cavernosum; so that they literally surround the back part of the urethra, constituting a complete sphincter muscle for it. This account of the accelerator urinæ being peculiar to myself, is adopted from a strong analogy between it and the sphincter vaginæ.

The two muscles are considered by M. Chaussier as forming but one: in that case its origin will be reversed, and commence in the middle line of the perineum instead of terminating there. As this muscle, and the erector penis, touch by their contiguous faces, it is difficult to get into the membranous part of the urethra in lithotomy without cutting through the muscular fibres of one or the other.

It propels the urine and semen forward.

The Musculus Transversalis Perinei,

As its name implies, passes directly across the perineum; it arises from the inner side of the ischium, just at the origin of the erector penis, and is inserted where the sphincter ani and acceleratores urinæ join.

I have observed that when the lower part of the accelerator was extended much below its usual line, and strongly developed, the transversalis was very irregular in its origin and course; consisting frequently of a few fibres which did not deserve the name of a distinct

muscle, and lying almost unappropriated in the adipose matter of the part.

Occasionally, a fasciculus of muscular fibres exists, called, by Albinus, Transversus Perinei Alter, which arises in front of the transversalis, and is inserted into the perineal junction just behind it; it seems generally to be a loose fasciculus of the accelerator urinæ muscle.

The use of these muscles seems to be to contribute to fix the bulb of the urethra.

The Musculus Sphincter Ani

Consists in a plane, an inch thick, of elliptical fibres immediately beneath the skin of the anus, and which surrounds the latter in order to keep it closed. The long diameter of the ellipsis is extended from the coccyx towards the symphysis pubes, and has its angles very much elongated; the anterior may be traced terminating insensibly in the posterior face of the scrotum. It has two fixed points, the last bone of the os coccygis behind, and the perineal union of the other muscles in front; its lateral diameter occupies about one-half of the space between the tuberosities of the ischia, and it is in the middle of this space. This muscle, besides the fixed points mentioned, has at its anterior and posterior ends, many fibres ending simply in the subcutaneous cellular substance, and which are much more superficial than the fixed points.

Besides closing the orifice of the rectum, it will draw the bulb of the urethra backwards, or the point of the os coccygis forwards.

The Musculus Coccygeus

Belongs to the interior of the pelvis. It arises, by a small, tendinous, and fleshy beginning, from the spine of the ischium, and lying on the anterior face of the anterior sacro-sciatic ligament, it is inserted into the side of the last bone of the sacrum, and of all those of the os coccygis.

It draws the coccygis forwards.

It frequently happens that there is, on each side in front, a small fasciculus of muscle arising from the inferior bone of the sacrum and inserted into the bones of the coccyx; it is called Sacro-Coccygeus.

A large quantity of adipose and cellular matter exists on the side of the rectum, between it and the parietes of the pelvis, concealing the perineal surface of the levatores ani muscles, and filling up a depression there called the Ischio-rectal fossa.

The Musculus Levator Ani

Arises, fleshy, from the back of the pubes near its symphysis, and from near the superior margin of the foramen thyroideum above the obturator internus muscle. It also arises from the aponeurosis pelvica, where this membrane is extended as a thickened semilunar chord from the superior margin of the thyroid foramen towards the spinous process

of the os ischium. This second part of the origin of the levator ani is defectively described in many books on anatomy. It is then seen to cross obliquely, as far as the spine of the ischium, that portion of the obturator internus which arises from the plane of the ischium.

From this extensive origin the fibres converge and descend backwards, and have three distinct places of insertion; the posterior fibres are inserted into the two last bones of the os coccygis; the middle, and by far the greater number, are inserted into the semi-circumference of the rectum between its longitudinal fibres and the circular fibres of the sphincter ani; and finally, the most anterior fibres pass obliquely downwards and backwards on the side of the vesical end of the membranous part of the urethra, and on the side of the prostate gland, and are inserted into the common place of junction of the perineal muscles.

The fore part of this muscle is, by some of the English anatomists, called the Compressor Urethræ.[1]

The Triangular Ligament of the Urethra, or the Fascia Perinei Profunda,

Is a membrane which fills up the space below the symphysis of the pubes, and answers there as a septum between the perineum and the pelvis; when closely examined, it is seen to connect itself to the internal edges of the rami of the pubes and ischia on the inner posterior sides of the crura penis as far down as the beginning of the latter. At its lower edge its ligamentous character is not so well defined. On its anterior surface is the bulb of the urethra, and just at the extremity of the latter, enclosed by the ligament, and adhering to it, are Couper's Glands. In contact with it behind, and adhering, is the prostate gland, covered by its fibrous capsule, which is a continuation of the pelvic aponeurosis over it. A perforation exists in it, through which passes the membranous part of the urethra. This opening is not very apparent, in consequence of its edges being continued a little distance on the canal; but by detaching them the whole becomes well defined. At this point there are some transverse fibres above and below, their ends attached respectively to the pubes. Mr. Guthrie[2] considers them as muscular, and has called them constrictor urethræ. Though well acquainted with this arrangement for many years, it has never appeared to me more than ligamentous.

The relative situation of the bulb and of the membranous part of the urethra is such that the former goes towards the anus, while the latter passes upwards towards the neck of the bladder; they consequently form a considerable angle with each other. The membranous part of the urethra is much the deepest, the recollection of which is all important in lithotomy, as it teaches us to avoid the one, and to cut into the other. It may also be observed, that the hole in the triangular ligament is an inch below the symphysis pubis.[3]

[1] Wilson's Anatomy, p. 198.

[2] Quain and Sharpey, vol. ii. p. 538.

[3] The curve of a catheter at its vesical end most suitable for ready passage along the membranous portion of the urethra, is formed by a little more than the fourth part of a circle of two and three eighths of an inch in radius; the segment thus formed being bent somewhat within its proper curvature so as to make a paraboloid line. From the top of the

By removing the upper corner of the triangular ligament, we are made acquainted with another just behind it, which is totally distinct. This ligament is half an inch broad, is thick and strong, particularly at its lower edge, and is very firmly attached laterally to each of the ossa pubes, just below the symphysis: it is a continuation of the ligamentous union of the symphysis pubis. Mr. Colles calls it pubic ligament with great propriety. I would suggest, as somewhat more expressive, the term Inter-Pubic Ligament;[1] as it serves to distinguish it from another called Pubic, which is above the pubes, and described in the account of the recti abdominis muscles. The breadth of this having been stated at half an inch, it is obvious that the hole in the triangular ligament is half an inch below its lower edge.

Pelvic Fascia.

The Pelvic Fascia (*aponeurosis pelvica*) connects the bladder to the sides of the pelvis. "This fascia descends from the ileo-pectineal line to about midway in the depth of the pelvis; here it is reflected from the surface of the muscle (the *levator ani*), and applies itself to the prostate gland and bladder, on the body of which it is ultimately lost. At the angle of its reflection, this fascia appears particularly strong and white, but becomes more weak and thin as it lines the muscle and covers the bladder. In tracing this membrane, it will be seen that from the pubes just below the symphysis, a pointed production of it, constituting its anterior margin, is fixed into the side of the neck of the bladder. This pointed production on each side is called, by most anatomists, the *anterior ligaments* of the bladder. Between them, just beneath the symphysis of the pubes, a pouch large enough to receive the end of the finger is formed by the union of the fasciæ of the two sides: this pouch connects the middle anterior part of the neck of the bladder to the lower margin of the symphysis pubis."[2]

This fascia adheres closely to the periosteum of the pubes, between the upper margin of the thyroid foramen and the crista of the pubes; about the middle third of the linea innominata it is obviously a continuous membrane with the iliac fascia which covers the iliacus internus muscle; but behind this, again, it arises from the remaining third of the linea innominata.

The portion of this fascia which Mr. Colles speaks of as particularly strong and white, forms a bow, the concavity of which looks upwards, one end of the bow being fastened to the pubes above the foramen

symphysis pubis to the anterior end of the membranous part of the urethra measures two and three quarters of an inch, and to the posterior end of the bulb of the urethra three and three quarters of an inch. In each case an inflexible instrument with the curve above was introduced along the canal of the urethra. If a gum catheter without its style be used, its flexibility will allow these points to fall one quarter of an inch further down.

This rule will be found very useful in lithotomy, and in cutting for the membranous part of the urethra for stricture attended with fistula in perineo. In the latter operation, it is decidedly better in many cases to begin the opening of the membranous part just in advance of the triangular ligament, as it is from its dilated state more readily found at that spot. The incision should also be carried along the upper middle line of the membranous part instead of below.

[1] See Symphysis Pubis.

[2] Colles' Surgical Anatomy.

thyroideum, and the other end to the ischium above its spine. The perineal surface of this bow is an important point of the origin of the levator ani. Above the bow this fascia is very thin, for the fibres of the obturator internus can be readily seen through it.

At the bow the fascia divides into two laminæ; one pursuing its course to the bladder and rectum, the other covers the lower part of the obturator internus muscle, and thereby constitutes the obturator fascia. The levator ani is interposed between these two laminæ. The aponeurosis pelvica also forms a bow or semilunar edge in front of the sacral nerves. The triangular ligament and this fascia are so identified in forming the capsule of the prostate, that the capsule in description may be referred either to the one or the other, or to both, according to the fancy of the describer.

CHAPTER II.

OF THE ORGANS OF GENERATION IN THE FEMALE.

The Copulative Organs in the female are, the Vulva and the Vagina; the Generative are the Uterus and the Ovaria.

SECT. I.—OF THE VULVA.

The term Vulva is applied to the most superficial of the copulative organs, and consists in the Mons Veneris, the Labia Externa, the Labia Interna, the Clitoris, the Vestibulum, the Orificium Urethræ, the Fourchette, and the Fossa Navicularis.

The Mons Veneris is the protuberance on the fore part of the pubes. Its size varies considerably, according to the state of obesity of the subject, in consequence of its being formed by a deposit of fat between the skin and the bone: in corpulent women it is very large and prominent, whereas, in such as are much emaciated, it simply describes the outline of the bones. The skin, there, is abundantly furnished with its peculiar glands, seated in the cellular texture beneath it, and about the size and shape of millet seed. At the age of puberty a growth of hair takes place upon it, which is not so long as the correspondent growth upon men, and is not so much disposed to spread itself over the lower part of the abdomen as life advances. In women who have abused coition, it is said that these hairs become much curled.

The Labia Externa are a continuation of the mons veneris downwards in the form of an oblong eminence on either side. Their elevation is produced in the same way by a deposit of fat beneath the skin. They are somewhat broader and more prominent above than below. On the side which is next to the thigh, the integument is common skin, sparingly covered with hair; but on the other face it is a mucous membrane, being a continuation of that of the vagina. The skin here, as well as

at the commencement of every mucous membrane, is insensibly changed into the latter. They have many sebaceous and perspiratory glands externally, and mucous glands internally, upon them.

Much cellular membrane, like that of the scrotum, is found in their interior structure; whereby they enjoy great extensibility in order to favor the dilatation of the parts in parturition. The rima which exists between them is the Fissura Vulvæ of authors, and is about twice the length of the orifice of the vagina; this arrangement of it gives increased facility to the expulsion of the fœtus.

The Fourchette, or Frænulum Vulvæ, is situated at the posterior commissure of the labia externa, and is a thin, narrow, transverse duplicature of the skin; which, owing to its weakness, is most frequently ruptured at the first act of parturition, and then disappears.

The Clitoris bears, in some respects, a resemblance to the penis of the male, but is by no means so large. It is situated immediately below the symphysis pubis, and consists in a cylindrical body of three or four lines in diameter, with two crura. The body is an inch long; the crura are likewise of the same length, and arising from the internal face of the crura of the pubes, unite beneath the symphysis so as to form the body. The body is not straight, but has the anterior half bent downwards and forwards. The exterior covering, or capsule of the clitoris, in its texture, resembles the elastic ligamentous membrane of the corpus cavernosum penis; and is, moreover, filled within by a similar cavernous or cellular structure, which is divided into two equal parts by a septum pectiniforme, and is susceptible of distension during sexual excitement. The clitoris is supplied also with blood-vessels and nerves like the penis, and is held up to the under part of the symphysis pubis by a suspensory ligament.

The anterior extremity of the body of the clitoris is found in the rima or fissura vulvæ, about an inch below the upper commissure of the labia externa. It projects somewhat, and bears a general resemblance in shape with the end of the penis, whence its name of glans clitoridis; but it has not the same organization, excepting the delicacy, the extreme sensibility, and the vascularity of the skin which covers it. The clitoris has no corpus spongiosum, neither is it concerned, like the penis, in conveying the urine from the bladder. Its glans is covered by a doubling of skin called the prepuce, and is likewise furnished with the glandulæ Tysoni, from which is discharged a smegma, or sebaceous fluid, as in the male. The prepuce does not furnish a regular well defined frænum.

The Erector Clitoridis muscle corresponds with the erector penis. It arises from the ascending ramus of the ischium, and, covering the inferior face of the crus clitoridis, runs as far forwards as the commencement of the body.

The Labia Interna, or Nymphæ, are two duplicatures of the mucous membrane of the vulva, which pass down, one on each side, from the clitoris. The prepuce of the latter terminates, on either side, in the labia; while the latter are continued upwards, by a narrow process, to

the under surface of the glans clitoridis. They arise all along their base, from the internal sides of the labia externa, or majora; and being wider in the middle than elsewhere, they terminate insensibly about half way down the orifice of the vagina. Between the laminæ of each one is placed a vascular cellular substance, susceptible of distension and of partial erection during sexual excitement. In young subjects, their vascularity communicates a vermilion tinge, which is lost and becomes brownish in the progress of life. As they are effaced during parturition, their chief use seems to be as a provision for the great distension of the vulva, which then occurs.

The labia interna are about half an inch broad in the natural state, and do not project obviously beyond the labia externa, except in cases of extreme emaciation, where the prominence of the latter has been destroyed by a removal of its fat. They are, however, very subject, as the individual becomes old, to a pointed elongation, increasing their breadth to an inch, or an inch and a-half; and to become thickened and indurated. A tribe of Hottentots, the Boschismans, living near the Cape of Good Hope, are uniformly subject to this enlargement; which, for a long time, was represented, by travellers, as an organ superadded to what is common in the human species.

The Vestibulum is a depression of twelve or fifteen lines long between the labia interna; it is bounded above by the clitoris, and below by the orifice of the vagina. It is abundantly furnished with mucous lacunæ.

The Urethra of the female has its external orifice (*orificium urethræ*) in the inferior part of the vestibulum, about one inch below the glans clitoridis, and is generally marked by a slight rising, which is easily distinguished by the sensation of touch alone; its margin is often bounded by a little caruncle on each side.[1] The urethra itself is an inch long, larger and much more dilatable than that of the male; its course is obliquely downwards and forwards from the neck of the bladder, passing under the symphysis of the pubes, and being slightly curved from that cause. It consists of two membranes, a lining and an external one. The lining membrane is a continuation of that of the bladder; it is thrown into several longitudinal folds, and has many mucous follicles in it. The external coat of the urethra consists of condensed laminated cellular membrane, having a strong affinity with muscular fibre: the principal direction of the fibres is transverse, forming a cylindrical body of half an inch in its transverse diameter, and which has given the idea of the existence of a prostate gland in the female. The lower and lateral surfaces of this cylinder are in contact with the vagina, forming a protuberance into its cavity; and the upper surface is firmly connected to the triangular ligament of the pubes. Immediately behind the neck of the bladder, we find the vesical triangle with its muscle, as in the male, excepting that the anterior angle of it goes to the anterior end of the urethra.

[1] Professor Pancoast considers the urethra of the young female to have its orifice on a level with the anterior face of the Symph. Pubis, whereas, in such as have borne many children, it is behind the pubes. Wistar's Anat. vol. ii. p. 182, Phila. 1839.

The Fossa Navicularis is that portion of the rima vulvæ which is below the vestibulum, and anterior to the orifice of the vagina.

SECT. II.—OF THE VAGINA.

The vagina is a thin membranous canal which leads from the vulva to the uterus. It is from four to six inches in length, differing according to age and pregnancy, and being much shorter in women who have borne children than in virgins. It is placed between the bladder in front, and the rectum behind, being flattened by them so as to bring its anterior and posterior surfaces into contact. Its anterior extremity is the smaller of the two, and presents its greatest diameter vertically, while that of the posterior is transverse. As it follows accurately the central line of the pelvis, it is, consequently, curved with its concavity forwards. Its anterior parietes are shorter than the posterior, both from the smaller depth of the pelvis in this direction, and from the mode of connection with the uterus.

The vagina is formed by two tunics: a fibrous and a mucous one. The first is external, of a light red color, highly elastic, and seems to consist of condensed cellular membrane, the fibres of which are much intermixed, and pass in every direction. It is vascular, and immediately adjacent to the large venous sinuses of the pelvis. The mucous membrane, being a continuation of that of the vulva, is at and near its anterior orifice of a vermilion tinge; while, posteriorly, it is grayish and frequently spotted, so as to give it a marbled appearance: its thickness diminishes as it recedes from the external orifice, and upon being floated in water, many mucous lacunæ are observable upon it.

The internal surface of the vagina is commonly covered with the mucus which comes from its lacunæ. On the anterior or pubic portion, it is divided longitudinally by a middle ridge, which commences by a sort of tubercle just below the orifice of the urethra, and proceeds backwards, becoming indistinct as it approaches the uterus. Transverse ridges, formed in the same way by folds of the mucous membrane, arise from the sides of the last at its anterior portion, and give a roughness to that part of the vagina. The inferior side, or that next to the rectum, has the same kind of arrangement of the mucous membrane, but not as distinct. In a majority of subjects, the uterine half of the vagina is perfectly smooth, but the rule does not always hold. The internal membrane of the vagina is covered by its epithelium, the scales or cells of which are detached and found in the secretion of mucus.

The Corpus Spongiosum Vaginæ is an erectile tissue, like that of the penis, and closely resembles in structure the corpus spongiosum urethræ. It is placed at the anterior end of the vagina, on its outer circumference, just below the clitoris, and at the base of the labia minora or interna. It is an inch broad, and a line or two thick, adheres closely to the fibrous coat of the vagina, and extends around the superior semicircumference of the orifice, but not around the inferior. It is frequently called Plexus Retiformis.

The Sphincter Vaginæ Muscle surrounds the anterior orifice of the

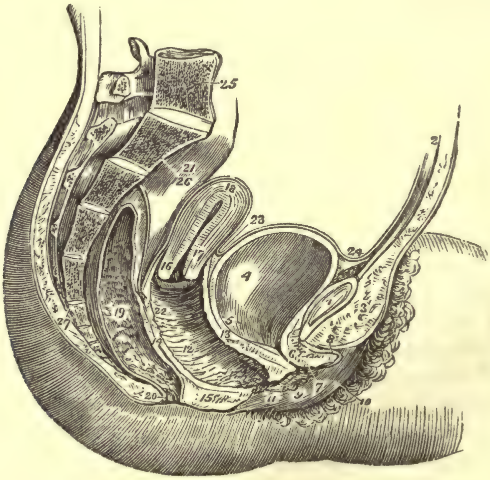
vagina, and covers the plexus retiformis. It is about an inch and a quarter wide, and arising from the body of the clitoris and the crus of the pubes, behind the crus of the clitoris, passes backwards and downwards to be inserted into the dense white substance, in the centre of the perineum, common to these muscles, the transversi perinei and the anterior point of the sphincter ani. There is a strong analogy between it and the accelerator urinæ of the male.

The Transversus Perinei of the female has the same circumstances of origin and insertion as in the male, but is not quite so strong.

On each side of the orifice of the vagina, near its middle, is frequently found a mucous gland, the Gland of Bartholine or Duverney, the size of a garden pea: it corresponds with Couper's gland of the male subject. This gland consists of agglomerated lobules, formed of cœcum-like vesicles, terminating in an excretory duct of eight lines in length. This duct discharges into the fossa navicularis, near the gland itself. It is very large in the panther.

The Hymen,[1] one of the attributes of the virgin state, is placed at the anterior orifice of the vagina for the purpose of closing it, and com-

Fig. 202.



A side view of the Viscera of the Female Pelvis.—1. Symphysis pubis. 2. Abdominal parietes. 3. The fat forming the mons veneris. 4. The bladder. 5. Entrance of the left ureter. 6. Canal of the urethra. 7. Meatus urinarius. 8. The clitoris and its prepuce. 9. Left nympha. 10. Left labium majus. 11. Orifice of the vagina. 12. Its canal and transverse rugæ. 13. The vesico-vaginal septum. 14. The vagino-rectal septum. 15. Section of the perineum. 16. Os uteri. 17. Cervix uteri. 18. Fundus uteri. 19. The rectum. 20. The anus. 21. Upper portion of the rectum. 22. Recto-uterine fold of the peritoneum. 23. Utero-vesical reflection of the peritoneum. 24. The peritoneum reflected on the bladder from the abdominal parietes. 25. Last lumbar vertebra. 26. The sacrum. 27. The coccyx.

monly remains until it is ruptured by violence. In all cases, except where there is an unnatural adhesion, it leaves a small orifice for the

[1] J. G. Tolber, Diss. de Variet. Hymen.—Haller, Icon. Anat. Fasc. i.—Albin. Acad. Annot. lib. iv.—Santorini, Septemd. Tab.

passage of mucus and of menstrual blood. In my own observations, I have found it most frequently crescentic, the convexity of the crescent presenting downwards, and the horns upwards; but in some cases it is to one side. Next in frequency to the lunated is the circular shape, where it surrounds completely the orifice and leaves a hole in its own centre. There are some other varieties, such as its being fleshy, fasciculated, unequally divided into two portions, and so on, which are narrated by different writers. Being simply a duplicature of the mucous membrane, it is generally so weak as to be ruptured at the first act of copulation; or even from slighter causes during infancy; but occasionally, it becomes thickened, and so strong as to require division with the knife. Upon the rupture of the hymen, its place is indicated in subsequent life by from two to six small tubercles, called Carunculæ Myrtiformes, which are its remains.

The peritoneum, in descending from the uterus, anteriorly, touches the top of the vagina for a little distance, and is then reflected to the bladder, but posteriorly, almost the upper half of the vagina has a peritoneal coat before this membrane is reflected to the rectum. The attachment of the vagina to the bladder is strong and close just above the urethra; but its connection with the rectum is by rather loose cellular substance.

SECT. III.—OF THE UTERUS, AND ITS APPENDAGES.

The Uterus, or Womb, is a compressed pyriform body, the larger end of which stands upwards, while the lower is directed downwards, and is attached to the vagina.[1] Unimpregnated, it is two and a half inches long, and one and a half in diameter at its widest part. The posterior face is very convex, while the anterior is almost flat, or very slightly convex. It is about one inch in thickness. It is divided by anatomists into fundus, body, and neck. The fundus is formed by its superior extremity, and comprises the space between the orifices of the Fallopian tubes: the neck is the lower cylindrical portion, of about an inch in length, and the body is the part intermediate to the two. On the exterior circumference of the uterus, there are no marks or lines distinguishing these several portions from each other.

The uterus, being destined to lodge the fœtus for a short period after conception to the moment of birth, has a cavity ready for its reception. The shape of this cavity bears some general, but not a rigid resemblance to that of the organ itself, and it is so much flattened as

[1] This is commonly represented by anatomists in their plates and descriptions as the position of the womb; it is, however, more so in advanced pregnancy than when empty. In my dissections generally, I have found the posterior face of the womb downwards, reposing upon the concavity of the rectum, and the os tincæ obliquely forwards; this position being probably produced by the superincumbence of the small intestines, and especially when the bladder is empty. When the latter is full, the peritoneum is reflected from the centre of the uterus to the posterior face of the bladder, and its traction has the effect of erecting the uterus in part from its nearly horizontal direction. In the dissection of a female, April 9, 1838, aged eighteen, who died from an affection of the brain, there being every evidence of soundness in the genital organs, I found the rectum making a curve to the right side of the inferior part of the sacrum, and the body of the womb reposing in the concavity of the latter.

to have its anterior and posterior parietes in contact, or nearly so. The cavity of the body is an equilateral triangle of eight or ten lines in diameter; the sides of the triangle are bent inwards in parabolic curves, in such a way as to present their convexities to the cavity of the uterus: this, of course, occasions an apparent elongation of the angles. The inferior angle is continued into the cavity of the neck, while the two superior run into their respective Fallopian tubes. From this arrangement it happens, that the parietes of the uterus are only three lines thick on the angles of the triangular cavity, while at the middle they are from four to six lines. The cavity of the neck has not its anterior and posterior sides so near together as those of the body, and is rather cylindrical, being smaller, however, at the upper and lower ends than in the middle. This arrangement gives to its sides a paraboloid curvature, which presents its convexity outwards, differing in that respect from the corresponding curvature in the cavity of the body.

The cavity of the neck terminates in the vagina by an orifice about the size of a small writing-quill, but ovoidal, and presenting its long diameter transversely. This orifice is the Os Tincæ, or Orificium Externum Uteri; frequently, without apparent disease, I have seen it conoidal, with its base, half an inch in diameter, presenting downwards. The upper orifice whereby the cavity of the neck communicates with that of the body is not subject to such fluctuations in size: it is occasionally called Orificium Internum Uteri, and is generally somewhat larger than a small writing-quill. The os tincæ is bounded before and behind by the lips of the uterus, formed by the projection of the neck into the vagina. For the most part the anterior lip is directly continuous with the anterior side of the vagina: so that its projection is very inconsiderable, and, indeed, not appreciable to the finger: at the same time, this lip is rather thicker than the posterior. The projection of the latter, on the contrary, is always well marked, because the vagina, instead of being inserted into its ridge, is joined to the posterior surface of its base.

The cavity of the uterus is lined by a very thin mucous membrane, a continuation of that of the vagina. This membrane is of a light pink color, which changes to a vermilion during the period of menstruation; it is said to be furnished with villosities, which, though seen with difficulty in the usual way, may be rendered apparent, by floating the uterus in water; and it adheres so closely to the substance of the uterus that it forms an inseparable portion of it, which can neither be dissected nor macerated off entirely, as in the case of other mucous membranes.

This membrane is smoothly laid upon the cavity of the body, and gives it a polished shining surface. On the cavity of the neck, it is wrinkled along the anterior and the posterior parts; there being a longitudinal line running along the centre, and on each side of this line transverse or oblique elevations or duplicatures. This arrangement presents an arborescent appearance, technically called the arbor vitæ. In the interstices of these duplicatures there are some small mucous glands or lacunæ, which, as their orifices are exposed to obliteration from inflammation or some other irritation, become distended into small

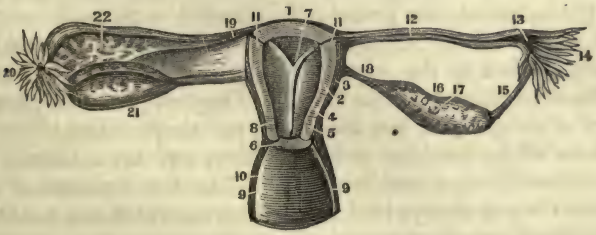
spherical sacs by the accumulation of their habitual secretion. Naboth, from seeing them in this state, mistook them for eggs, or the rudiments of the fœtus, and the error has been commemorated by their being called Ovula Nabothi. This membrane is covered by an epithelium which is vibratile to the middle of the neck, and afterwards pavement-like.

The uterus is covered completely by the peritoneum; in the reflection of the latter from the rectum to the bladder, it adheres to the uterus by a subjacent cellular substance, which allows it to be dissected off without difficulty. The same duplicature of peritoneum which encloses the uterus is also reflected from each of its lateral margins, by their whole length to the corresponding side of the lesser pelvis, and forms the Lateral or the Broad Ligaments (*ligamenta lateralia, lata*). The peritoneum, in passing from the uterus forwards to the bladder, forms on each side a duplicature, not very distinct, and depending, in a measure, upon the state of the bladder; this constitutes the Anterior Ligaments. The same membrane, in passing from the back of the uterus to the rectum, and in covering the posterior superior end of the vagina, also forms, on each side, a duplicature, denominated the Posterior Ligaments; they are always better seen than the anterior. Muscular fibres are said to be found, occasionally, between the laminæ of these several duplicatures, running in the direction of the latter;[1] they have not been presented to me in such a way as to arrest my attention.

The broad ligaments, along with the uterus, form a transverse septum, passing from one side of the pelvis to the other; and contain, between their laminæ, the arteries and the veins which belong to the uterus and ovaries.

Besides the duplicatures of peritoneum, the uterus is retained in its position by the Ligamenta Rotunda, one on each side. These round

Fig. 203.



The Uterus, Fallopian Tubes, Ovaries, and a part of the Vagina of a Female of sixteen years. On one side the tube and ovary are divided vertically; the other side is untouched. The anterior portions of the uterus and vagina have also been removed.—1. Fundus of the uterus. 2. Thickness of its parietes anteriorly. 3. External surface of the uterus. 4. Section of the neck of the uterus. 5. Section of the anterior lip. 6. Its posterior lip untouched. 7. Cavity of the uterus. 8. Cavity of its neck. 9. Thickness of the walls of the vagina. 10. Its cavity and posterior parietes. 11. Openings of Fallopian tubes into the uterus. 12. Cavity of the left tube. 13. Its trumpet-like mouth. 14. Corpus fimbriatum. 15. Its union with the ovary. 16. Left ovary vertically divided. 17. The vesicles in its tissue. 18. Ligament of the ovary. 19. Right Fallopian tube untouched. 20. Its corpus fimbriatum. 21. Right ovary. 22. The broad ligament.

ligaments arise from the side of the uterus, a little below the insertion of the Fallopian Tube, and going between the laminæ of the broad

[1] J. F. Meckel, vol. ii. p. 605.

ligament, reach, finally, the internal abdominal ring; they then traverse the abdominal canal and the external ring after the manner precisely of the spermatic chord, and terminate by several fasciculi in the fatty cellular matter of the mons veneris and of the labia majora. The round ligaments are rather smaller in the middle than at either extremity; they consist of a condensed cellular or fibrous structure, and have many blood-vessels in them. It has been asserted,[1] that they contain strongly marked muscular fibres; some of which come from the uterus, and others from the broad muscles of the abdomen. No evidence of this fact has as yet been presented to me, though I do not deny it; and, indeed, I think it probable that such fibres may be developed there during gestation.

The texture of the uterus is very compact, and of a cartilaginous feel; it is composed of fibro-muscular matter, intermixed with a great many blood-vessels. In regard to its fibrous structure, there is no subject in anatomy upon which opinions are more divided, or more authoritative and numerous on both sides of the question. Some deny its existence at any period, while others admit it as a constant condition; others, again, limit its duration only to the period of pregnancy. Without dwelling on the value of the several doctrines, and the means and observations tending to support them, it may be sufficient here to mention that the structure of the uterus takes on very important and strongly marked changes, in passing from the unimpregnated state to that of advanced gestation. In the first the fibres look ligamentous, and pass in every direction, but so as to permit the uterus to be lacerated more readily from the circumference to the centre than in any other course: it indeed manifests an indisposition to be torn in a laminated manner. The fibres, moreover, break off short, are separated by the blood-vessels, and seem to contain, in their interstices, something like fibrine.

In the impregnated state, on the contrary, the vessels being immensely increased in size, the laminated structure becomes very evident, and submits readily to the tearing of one layer from the other: these laminæ consist of fibres, which are principally parallel with each other. The muscular nature of these fibres seems to be sufficiently proved, by their powerful contraction in the expulsion of the fœtus, and on being irritated by the introduction of the hand. They are, however, not red like the muscles of animal life, but are plain, not striped, and of a very light color, as those of the bladder and intestines; and are collected into fasciculi of peculiar flatness and looseness. The development of this muscular structure is not always limited to the pregnant state, but is disposed to manifest itself on many occasions which produce an increased size in the uterus. This fact was first exemplified to me in a small scirrhus of a virgin uterus, presented by Dr. Hugh L. Hodge,[2] and has been still farther confirmed in a case where the scirrhus was five or six inches in diameter; also in a virgin uterus, very much enlarged from scirrhus, presented by Professer Charles D. Meigs.[3] A similar fact has been noticed by Lobstein, of Strasburg, where the tumor was also steatomatous.

[1] J. F. Meckel, loc. cit.
[2] Now Professor of Obstetrics in the University of Pennsylvania.
[3] Of the Jefferson Med. College.

The fibres of the uterus, examined near the term of pregnancy, consist in two planes separated by the large blood-vessels; one within and the other without. These layers are readily divisible into subordinate laminæ, intermixed with one another, but yet to a considerable extent separable. The external layer is thicker than the internal, and both have an increased thickness at the fundus: while they are much diminished, and indeed indistinct, at the cervix.

The fibres generally are either circular or longitudinal, but many of them are oblique. The exterior surface of the external plane is composed principally of longitudinal fibres, within which are the circular. The inner plane, on the contrary, has the circular fibres external, and the longitudinal internal. In both planes the circular fibres are more abundant at the fundus, and the longitudinal upon the body of the uterus; but, generally speaking, there are collectively more longitudinal than circular fibres.

Of the Fallopian Tubes.

The Fallopian tubes (*tubæ Fallopianæ*) are two membranous canals, one on either side, fixed in the superior margin of the broad ligament of the uterus. They serve to conduct the rudiments of the embryo from the ovarium into the uterus. They are about four inches long, and extend from the upper angle of the uterine cavity to the side of the pelvis: their outer extremity is loose, and hangs upon the posterior face of the broad ligament over the ovarium, consequently inclines downwards, thereby forming an angle with the other portion.

At their uterine extremities the Fallopian tubes are about the size of the vas deferens, resemble it strongly, and scarcely admit a hog's bristle; but, having proceeded about one-half of their length, they begin to enlarge, and continue to do so rapidly for an inch, until they reach the size of a writing-quill; they then contract again somewhat, and immediately afterwards expand into a broad trumpet-shaped mouth. The latter has an oblique orifice, the edge of which is extremely irregular, by being resolved into a number of ragged, fringe-like processes, of unequal size and length; and which, as a whole, are called Corpus Fimbriatum, or Morsus Diaboli. One of the longest of these processes adheres to the external end of the ovarium.

The Fallopian tube is covered by the peritoneum, and consists of two coats: the external is fibrous, and bears sufficient resemblance to the structure of the uterus to be considered a continuation of it; the internal is mucous, and is likewise a continuation of the corresponding one of the uterus. The external end of the tube, which is called Pavillon by the French anatomists, is flaccid, thin, and generally in a collapsed state, as it is formed solely by the mucous membrane, assisted by the peritoneum, neither of which furnishes resistance sufficient to keep it expanded; but, as many blood-vessels enter into its composition, their turgescence, in sexual excitement, probably communicates a certain degree of erection.

Mr. Grainger has ascertained that the Fallopian tube presents a difference in the structure of its mucous membrane, the part next the uterus not being so vascular as the other part: moreover, the latter

presents a complex arrangement in the form of folds or valves running in a longitudinal direction and plaited. We are left to infer that the difference is more conspicuous shortly after conception.[1] There is some similitude in this arrangement with the oviducts of birds, one part of which secretes the albumen of the egg, and another part the shell; and it may be in the human subject, also, that the two parts execute different offices in the perfection of the ovum.

Of the Ovaries.

The Ovaries (*ovaria, testes muliebres*), two in number, one on either side, are situated on the posterior face of the broad ligaments by a duplicature of which they are surrounded, and are twelve or fifteen lines below the Fallopian tubes. Their shape is that of a compressed ovoid, about half the size of the male testicle: their long diameter is horizontal; they are suspended from the broad ligament rather by the edge than by the flat surface, so that they project, and are to a considerable degree pendulous. Their distance from the uterus varies from an inch to an inch and a-half, and from the internal end of each one there proceeds a small vascular fibrous cord, the Ligament of the Ovarium, which is inserted into the uterus, somewhat below the origin of the Fallopian tube.

From their being the seat of conception, they have, in the youthful and healthy female, a pliancy and succulency, indicative of their state of preparation for the act; but in advanced life they diminish much in volume and become hard and dry. Their surface, originally smooth or slightly embossed, is subsequently rendered uneven by repeated acts of conception, leaving on it a number of cicatrices or small stellated fissures. They are of a light pink color.

Within the peritoneal coat is another, the Tunica Albuginea, of a strong compact, fibrous texture, like the same coat of the testicle, and sending inwards many processes.

The structure of the ovarium is as follows. But few females, of those presented in our dissecting rooms, have the part in a state fit for study, owing to age, disease, or excessive sexual indulgence: my best opportunities have been derived from post-mortem examinations, in private, of individuals of from fourteen to twenty, where the virgin state had been preserved. When an ovarium of the latter kind can be got; by cutting through the tunica albuginea simply, and then tearing open the organ, it will be found to consist of a spongy fibrous tissue, abundantly furnished with blood-vessels from the spermatic artery and vein. In this spongy tissue, called Stroma,[2] are the Gräafian vesicles (*ovula Gräafiana*), from fifteen to twenty spherical bodies, according to the commonly received opinion; but in an ovarium exhibited to me by the late Dr. John Hopkinson, there were thirty-six distinct vesicles, and on some occasions fifty have been counted. They have two coats, and vary in size from half a line to three lines in diameter; the larger ones are nearer the surface, and from having caused the absorption of

[1] Muller's Physiol. p. 1563.
[2] By Von Baer, from its being a bed (stratum).

the tunica albuginea, may sometimes be seen through the peritoneal coat, and give to the surface of the ovarium an embossed condition. The vesicles contain a transparent fluid having within it the rudiments of the embryo. As the vesicles are evolved, they advance from the centre to the circumference. Their parietes are thin, transparent, and have creeping through them minute arterial and venous ramifications. The bed of the ovarium in which a vesicle reposes is called the calyx.

To Von Baer[1] belongs the merit of discerning first the ovulum of man and of mammalia in the Gräafian vesicle. The Ovulum occupies but a very small part of the cavity of the Gräafian vesicle, the remainder being filled with an albuminous fluid in which microscopic granules float. By discharging the fluid from a Gräafian vesicle, the Ovulum can with a simple lens be detected in a globular form and floating in this fluid. By flattening out this little globe under a thin plate of glass, and then examining with a compound microscope, it will be seen that it consists of a transparent membrane containing a Vitellus or yolk, made of granules or cells and fat globules.

Within the above vitelline membrane is placed the Germinal vesicle of the human subject,[2] being about $\frac{1}{60}$th of a line in diameter. This vesicle has also the germinative spot, macula germinativa of Wagner, which is from the $\frac{1}{200}$th to $\frac{1}{300}$th of a line in diameter.

The Ovula Gräafiana seldom project much on the surface of the ovarium in the human subject; but in other animals, as the common hen, they, upon being developed, stand out so much as to resemble a cluster of berries, each attached by its pedicle, and surrounded by its two appropriate sacs. These sacs constitute what are called the capsule of the ovum, or the ovisac. Upon the inner surface of this capsule, according to the observation of Schwann, is to be found a layer of epithelial cells in the different classes of animals, as, for example, in the ovicapsules of fish, and in the Gräafian vesicles or ovules of mammalia. The existence of these epithelial cells is considered as proof positive of the sameness of the membrane in whatever animals it may be examined; and, therefore, that the ovicapsules of oviparous animals are identical with the Gräafian vesicles or ovula of mammalia. The stages of development in an egg are therefore simply the expression of what occurs also in a Gräafian vesicle.

Within the ovicapsule of Birds is the yolk (*vitellus*) surrounded by its membrane called vitelline, which, being at first in contact with the capsule, is afterwards separated from it in many animals by a well marked and large interval. The yolk is formed of fine cells containing granules and oil globules.

In the substance of the yolk is the vesicle of Purkinjé, or the Germinal vesicle. This vesicle contains a transparent fluid, and has on it a nucleus, called the macula germinativa. This vesicle in the fully formed ova of the oviparous vertebrata is imbedded in a disk-shaped layer of granular substance, called the *germ disk.* The germinal

[1] Müller, p. 1469.

[2] Discovered by Coste in 1834, and more distinctly explored by Valentine and Bernhardt. Müller, p. 1471.

vesicle is finally lost by commingling with the granular matter of the germ disk, in which the first rudiments of the embryo are formed.

Upon the ovum leaving the ovarium in a bird, it has to pass through the oviduct, and in doing so receives as a deposit upon it the white or albumen, and subsequently the shell which is also due to the secretory action of the oviduct.[1]

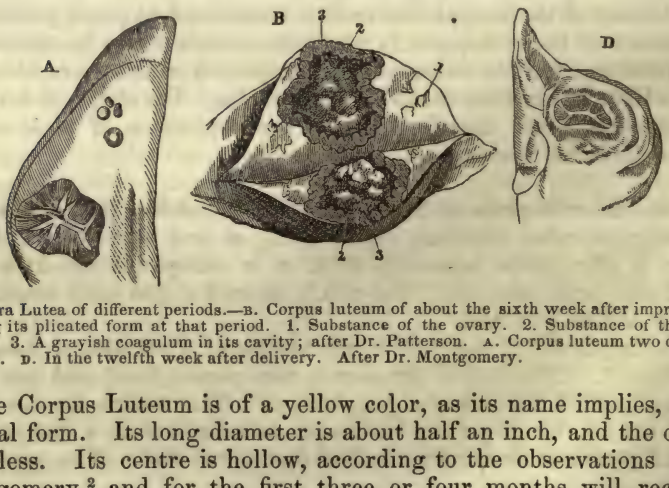
The analogy is thus seen to be striking between the evolution of a common egg and the ovule of the human subject, found in the Gräafian vesicle.

A very remarkable point, mentioned by Carus, is that all the essential parts of the ovulum can be detected in the ovary of the mature embryo of the human subject or of mammiferous animals; hence the preparation for a new generation seems to begin at a very early period of life.

When an ovulum is discharged from a Gräafian vesicle, the latter and the surrounding calyx open in a stellated line: this line of dehiscence or gaping is in birds preceded by a whitish arched band called the *stigma*, which indicates the place for the escape of the ovum. There appears to be some analogy in this with the spontaneous fissure of the rind or bur of certain fruits.

Upon the escape of the contents of the Gräafian vesicle the latter is sometimes filled with coagulating lymph or blood. It also undergoes a pullulation or granulation from its interior surface, so as to form a body called the Corpus Luteum, which being after a while absorbed the vesicle collapses and shrivels, and the stigma then remains as a stellated cicatrix. Sometimes the entire surface of the ovarium is marked with these stigmata.

Fig. 204.



Corpora Lutea of different periods.—B. Corpus luteum of about the sixth week after impregnation, showing its plicated form at that period. 1. Substance of the ovary. 2. Substance of the corpus luteum. 3. A grayish coagulum in its cavity; after Dr. Patterson. A. Corpus luteum two days after delivery. D. In the twelfth week after delivery. After Dr. Montgomery.

The Corpus Luteum is of a yellow color, as its name implies, and of an oval form. Its long diameter is about half an inch, and the other a little less. Its centre is hollow, according to the observations of Dr. Montgomery,[2] and for the first three or four months will receive a

[1] A satisfactory explanation of the above process, according to Wagner and others, is found in Müller's Physiol. p. 1468, London, 1842.

[2] See Pr. of Hum. Physiol. by W. B. Carpenter, p. 692, Philada. 1850.

grain of wheat. It is vascular, and may be injected from the vessels of the ovary, which will distinguish it from tubercular or other deposits. As gestation proceeds, the cavity is obliterated, and only an irregular white line is left in the place of it. This line itself finally disappears after delivery. The cicatrix, it was once believed, is permanent; but Dr. Montgomery seems to have disproved even that, so that there is no correspondence between the number of stigmata and of children born.

The phenomena attending the formation of the corpus luteum have elicited great interest, of late years, and many very scientific observations have been made on the subject by Bischoff,[1] Wagner,[2] Huschke,[3] and others.

The Organs of Generation in the female are supplied with blood principally from the internal pudic and other branches of the hypogastric artery: the corresponding veins run into the hypogastric. Their nerves come from the sacral and from the hypogastric plexus. The arteries of the Ovarium come from the Spermatic and from the uterine. Former anatomists considered the spermatic to be the principal one; the opinion is now changing in favor of the branch of the uterine. The spermatic veins discharge as in the male subject.

The Bladder and the Rectum, with unimportant exceptions, are the same in both sexes. The Levator Ani, the Coccygeus, and the Sphincter Ani, are also similar. The pelvic aponeurosis in the female, besides connecting the bladder to the sides of the pelvis, is attached to the anterior part of the vagina. The triangular ligament of the urethra also exists, but under circumstances somewhat modified by the close connection of the urethra with the vagina.

CHAPTER III.

OF THE LACTIFEROUS GLANDS, OR BREASTS.

The Breasts (*mammæ*) of the female are intended for the secretion of milk, and thereby to maintain the connection between mother and infant for some time after the uterine life of the latter is passed. All mammiferous animals exercise this function: in birds there is a sort of substitute for it, in the changes which take place in the first stomach or crop during incubation. In the male subject there is, also, a small glandular body on each side, which has the same organization as in the female, but is in miniature, and always remains in a collapsed

[1] Trait. de Dévelop. de l'Homme, Paris, 1843.
[2] Elements of Human Physiol. Part I. London, 1841.
[3] Traité de Splanch. Paris, 1845.

state, with some rare exceptions; when it has been known to expand in volume, and to furnish a secretion, as in the female.[1]

The Breasts are two in number, one on either side; they are situated on the same level, in front of the pectoralis major muscle, and between the arm-pit and the sternum. They are hemispherical, and have their base united to the muscle by a thin lamina of loose, extensible, cellular substance, containing, even in corpulent women, but little fat. The skin which covers the front of this gland is very fine and thin, so that the blood which circulates in its veins may be readily seen. Between the skin and the front surface of the gland, there is a considerable thickness of cellular adipose matter, which, from its superabundance in some individuals, gives to them an appearance of having the glands enormously enlarged. There is, however, a great variety in the size of the glandular structure itself; for, in females who are youthful and giving suck, they are much larger than in such as have passed the period of child-bearing, and whose health is impaired. When all the fatty matter has been removed from a breast, and it is permitted to repose upon a table, its hemispherical shape disappears, and it then seems rather a flattened circular disk, of from four to five inches in diameter.

The mamma is of a very light pink color, and though very flaccid and yielding on being handled, its texture is actually extremely tough, and is cut only by much force. With the exception of bone, it is among the most trying of tissues to the edge of a knife. Its grosser arrangement consists in lobes of different sizes, united in such a way by cellular texture that, though they can be pulled somewhat apart, they cannot be entirely separated without injury. These lobes, when examined through the skin, give to the gland a knotted feel, and are sometimes partially affected by inflammation, so as to become still more distinct. The lobes are composed of Lobuli, which are resolvable, by maceration and particular modes of treatment, into small graniform masses (*acini*) about the size of millet seed, and which contain the ultimate glandular arrangement. The acini themselves consist of very small oblong vesicles, united by cellular substance, and by the common blood-vessels; and are very apparent by the aid of a microscope in a lactescent gland.[2]

These vesicles (*cellulæ lactiferæ*) have a diameter from ten to thirty-five times greater than that of the smallest capillary vessel of the body,[3] or, according to Krause, from the $\frac{1}{27}$th to the $\frac{1}{14}$th of a line.

[1] In a male patient, a resident in the Philadelphia Almshouse, the phenomenon of a full evolution of the glandular structure in both breasts is manifested. The individual (James McIntyre) is forty five years of age; the breasts are as large as those of a nursing woman; but the nipples are not proportionately evolved. Though his frame is robust, and well set, the voice is feminine; his external organs of generation are about the size of those of a boy of fourteen or fifteen. Thinking that there might be an internal state approaching to hermaphrodism, he informed me, on inquiring, that in earlier life he had the common inclinations for the female. He also informed me that this unusual development took place seven or eight years ago, owing to an excessive salivation; but, as he has a reserve on the subject, this statement may, probably, be received with some qualifications. I have also seen a second case, in which the voice is weak and feminine, but the genital organs have not been examined.—July, 1826.

[2] Marjolin, Manuel D'Anat. J. F. Meckel, Manuel D'Anat.

[3] Müller, loc. cit. p. 488.

The vesicles terminate by free openings into the incipient extremities of the lactiferous ducts.

Each vesicle is surrounded by a fine close vascular net-work, which is displayed upon its walls, but, according to the opinion of the day, does not discharge into it. They merely furnish material to the nucleated cells which prevail here as in other glands over the entire secretory surface of vesicles and of tubes.

The Excretory Ducts (*ductus Galactophori, lactiferi*) of this gland are numerous.[1] They are of an arborescent shape, and begin by very fine extremities or ramuscules in the acini; the ramuscules from several acini coalesce into a larger branch; several branches unite to form one still larger, and so on, successively, until a lactiferous trunk, constituting as it were the body of the tree, is formed by this assemblage. These trunks vary considerably in size, according to the number of tributary branches. Having got towards the centre of the gland near the nipple, from two to four of them, according to Cubolo, run into a common tube or root, called a Lactiferous Sinus. These Sinuses are in all about fifteen: they are only a few lines long, and differ in size; some being not larger than one lactiferous duct, while others have a diameter of from two to three lines. The sinus at the end next to the nipple terminates in a sort of rounded cul-de-sac; but from the extremity of the sac a conoidal tube arises which runs through the nipple, and conducts the milk: the point of this tube ends on the top of the nipple. This tube, from its shape, is suited to the retention of milk; in addition to which, it is sometimes dilated in the middle. It is curved when the nipple is not in a state of erection or stretched out, and terminates by an external orifice, which is much obscured by the papillæ of the nipple, and which is so small as to be seen with difficulty by the naked eye.

The excretory ducts of the breast, under which term may be comprehended the lactiferous ducts, the sinuses, and the conoidal tubes in the nipple, are formed by a soft, thin, and semi-transparent membrane, very capable of extension and of contraction. The trunks generally go deeply through the substance of the gland, and are tortuous, but do not anastomose laterally with one another; whence it happens that the lobes and lobules of the gland are arranged into sections, each of which has its appropriate excretory duct. In order to make a complete injection of the gland, each sinus must be separately injected through its conoidal tube. This rule is not of universal application, as in some experiments performed by the elder Meckel upon women advanced in pregnancy and during lactation, he succeeded in forcing mercury through one sinus, by its ramifications, into those of another: this route was supposed to have been through the finest extremities of the ducts. The whole gland itself may, however, from the infrequency of this circumstance, and from the difficulties and partial condition of these anastomoses, rather be considered as a congeries of smaller glands kept

[1] Alex. Kolpin, Dis. Inaug. de Struct. Mam. Cubolo, Append. ad Septemd. Tab. Santorini. Girardi, Append. ad Septemd. Tab. Santorini.

distinct by the interposition of cellular substance between their lobes; but joined, in one respect, by having the terminations of their excretory tubes collected into one bunch in the nipple. This latter circumstance seems to be only a provision for the more convenient sucking of the infant.

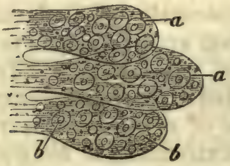
Fig. 205.

Lactiferous Tubes in part, during lactation.—1, 2. Top and base of the nipple. 3. Conoidal tubes of nipple. 4. Two in the nipple which are filled. 5. Lactiferous sinus at the base of the nipple. 6. The peripheral end of the lactiferous ducts. 7. Lobules of the gland. 8. The orifices of the tubes on the nipple.

The excretory ducts are nowhere furnished with valves, which accounts for the facility with which they may be injected backwards from the nipple. An opinion was entertained by Haller, and by other anatomists after him, that some of these ducts originate in the surrounding cellular substance, but this has been refuted by the researches of Cubolo. Some anatomists have thought that there is a direct communication between the ends of the lactiferous tubes and the arteries, veins, and lymphatics. Mascagni, after a very successful injection of the gland, whereby its vesicles were filled with quicksilver, not meeting with such an occurrence, was induced to think that, when the communication did happen, it was produced by rupture.

The membrane of the lactiferous canals is somewhat yellow, and upon a transverse section of the gland may be distinguished by its color. It

Fig. 206.



a, a. Terminal Follicles of Mammary Gland, with their secreting cells. *b, b.* The nuclei.

Fig. 207.

Terminal Extremities of Milk-Ducts in Follicles; from a mercurial injection by Sir A. Cooper; enlarged four times.

is covered internally by epithelial cells, which are almost everywhere pavement-like, according to Pappenheim. They are the real secernents

of the milk. Upon their removal he found transverse elastic fibres, covered with longitudinal fibres and numerous cellular fibres, but no muscular.

The Areola,

In virgins, is a rose-colored circle, which surrounds the base of the papilla or nipple. In women who have borne children, or in those whose age is advanced, it becomes of a dark brown. The skin of the areola is extremely delicate, and on its surface, particularly in pregnant or nursing females, there are from four to ten tubercles, which sometimes form a regular circle near its circumference, and in other subjects are irregularly distributed. Each of these tubercles has near its summit three or four foramina, which are the orifices of the excretory ducts of a little gland forming the tubercle. The areola consists of a spongy tissue beneath which there is no fat; it is susceptible of distension during lactation, or from particular excitement.

The greater number of anatomists have considered these tubercles as intended only for the secretion of an unctuous fluid which lubricates the areola and nipple, and protects them from excoriation in the sucking of the infant. It is said, however,[1] that when some time has elapsed after a repast, or when there has been a long interval to the nursing of the child, milk flows from them abundantly; but that in reverse circumstances a transparent, limpid fluid is distilled in small drops; all of which would tend to prove that they are of the same nature with the mammæ themselves, being only smaller. In addition to them, it is said that the areola and the nipple are furnished with a great number of sebaceous glands, which do not elevate themselves above the surface, and which may be found on and near the tubercles.

The Papilla

Is the truncated cone in the centre of the mamma, of the same color with the areola, and surrounded by it. The lactiferous tubes, as stated, terminate on its summit. It is collapsed and in a very pliable state for the most part, but when excited it swells, becomes more prominent, and of a deeper color. Its skin is rough, and provided with numerous and very small papillæ. Its internal structure consists of the extremities of the lactiferous tubes united by condensed cellular membrane.

The mamma is supplied with blood from the external thoracic, the intercostal, and the internal mammary arteries. Its veins attend their respective arteries. The nerves come from the axillary plexus and from the intercostals. The lymphatics run into the internal mammary, intercostal, and axillary trunks.

Among the anomalies affecting this gland is the existence of a supernumerary nipple; but sometimes there is a second gland entire on one or both sides, and commonly placed below the normal one.

[1] J. F. Meckel.

[illegible]

BOOK VII.

OF THE ORGANS OF RESPIRATION.[1]

The Organs of Respiration are the Larynx, the Trachea, and the Lungs.

CHAPTER I.

OF THE LARYNX.

The Larynx is an irregular cartilaginous tube that forms the upper extremity of the windpipe. It is situated immediately below the os hyoides and the root of the tongue, where it may be felt readily through the integuments, and by its prominence contributes to the outline of the neck. Its position is such that it is bounded behind by the pharynx, which is interposed between it and the vertebræ of the neck, and laterally by the primitive carotid arteries and the internal jugular veins. It gives passage to the air which is inhaled into the lungs or exhaled from them, and also contributes essentially to the production of the voice. Its special use, on the latter occasion, has induced some anatomists to give it a description apart from that of the other organs of respiration; but, as the function of voice is subordinate to that of respiration, I have preferred an observance of its most natural and local connections.

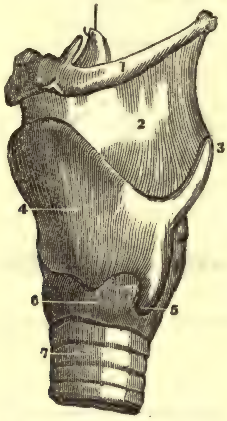
Five distinct cartilages form the skeleton of this structure: the os hyoides, which is common to it and to the root of the tongue, also contributes to its superior part in a manner which will be presently mentioned. The cartilages are one Thyroid, one Cricoid, one Epiglottis, and two Arytenoid.

The Thyroid Cartilage (*cartilago thyroidea*) is the largest of the five, and being placed about one inch below the os hyoides, produces in the upper part of the neck the prominence called Pomum Adami. It consists in two lateral halves, which in most individuals are perfectly symmetrical, and are continuous with each other on the middle line of

[1] For a very instructive paper on the Mechanism of Respiration in different Animals, author Francis Sibson, Esq., see Philos. Transactions, London, 1846.

the body. These two sides form at their line of junction an angle projecting forwards, and resembling that of the canal or hydraulic

Fig. 208.



A latera. view of the Larynx.—1. Os hyoides. 2. Middle thyro-hyoid ligament. 3. Cornu majus of the thyroid cartilage. 4. The angle and side of same. 5. Cornu minus. 6. Lateral portion of the cricoid cartilage. 7. Rings of the trachea.

gate: the superior part of the angle is more prominent than the inferior; particularly in the male subject. The sides of this body lean outwards, by which its transverse diameter above is increased.

The angle is terminated above by a deep notch (*incisura thyroidea*), from which the superior margin begins to form a curvature, on either side, like the letter S; the inferior margin is also somewhat curved, but to a smaller degree. The posterior margin of each half is nearly straight, but is elongated above, with the aid of the upper margin, into a long process, the Cornu Majus; and below, with the aid of the inferior margin, into another process not so long, Cornu Minus.

The internal surface of each half of the thyroid cartilage is flat. The external lateral part is marked by an oblique ridge (*linea obliqua*) indicating the termination of the sterno-thyroid and the beginning of the thyro-hyoid muscle. It proceeds from below upwards and backwards, and has a tubercle at each end.

The Cricoid Cartilage (*cartilago cricoidea*) is placed below the thyroid, and is the base of the larynx. It is an oval ring, of an unequal breadth and thickness, the thickness increasing constantly from before backwards.

Its inferior margin is nearly straight and horizontal, and is connected to the first ring of the trachea by the crico-tracheal ligament; it is also thinner than the superior: the latter is very oblique, and rises from before backwards and upwards so abruptly, that the breadth of the cricoid cartilage behind becomes three times as great as it is in front, under the inferior margin of the thyroid cartilage. The superior margin has on each side, behind, a little head, or convexity, which receives the base of the corresponding arytenoid cartilage, and forms with it a ball and socket joint.

The interior surface of the cricoid cartilage is smooth, and covered by the lining membrane of the larynx. Its exterior surface is flattened behind, on each side, by the posterior crico-arytenoid muscle; it is marked also laterally by other muscles, and by the inferior cornu of the thyroid cartilage.

The Cricoid cartilage is embraced by the inferior margin of the thyroid, but in such a way that a triangular interval is left in front between the two cartilages.

The Arytenoid Cartilages (*cartilagines arytænoideæ*) resemble triangular pyramids curved backwards, and are about six lines long. They are placed on the upper margin of the cricoid cartilage behind. The anterior face of each is uneven, and divided into two small concavities; the posterior face forms a single cylindrical concavity; and the internal face, by which it approximates its fellow, is nearly flat. When joined together, the two cartilages resemble the mouth or spout of a pitcher, from whence their name. Their bases are hollowed into a small glenoid cavity, for articulating with the cricoid cartilage.

A synovial capsule is reflected over the articulation, between the arytenoid and the cricoid cartilage; this capsule is strengthened by a few scattered ligamentous fibres.

The Epiglottis Cartilage (*epiglottis*) is situated on the posterior face of the base of the os hyoides, being enclosed partially by the two sides of the thyroid cartilage. Its general form is that of an oval disk; the upper margin of it is thin and rounded, partially curled forwards, and the lower part is elongated into a pedicle which adheres to the entering angle of the thyroid cartilage. I have uniformly found its lateral margin attached by a thin elastic membrane to the entire length of the upper thyro-arytenoid ligament.

Its surfaces, though nearly flat, are not fully so; for, anteriorly, it forms a cylindrical convexity, and posteriorly, a cylindrical concavity, from side to side. When nicely stripped of its covering, a number of very small foramina is seen to exist in it, which are considered to give passage principally to the ducts of muciparous glands. Its connections, aided by its natural elasticity, keep it in a vertical attitude behind the base of the tongue; its rounded margin is elevated above the latter, and overlooks it, so that in many persons it may be seen when the mouth is open and the tongue out.

In addition to the preceding cartilages, there are always two, and sometimes four others. On the top of each arytenoid is to be found one as an appendage or cornicle (*corniculum laryngis or Santorini*); it is somewhat triangular and elongated: its inferior face is attached by a few ligamentous fibres to the end of the arytenoid; it is included in the soft parts, and is very movable. The others (*cartil. Wrisbergii*), when they exist, which is rare, are found on the margin of the glottis, in the duplicature of the membrane which is extended from the side of the epiglottis, to the tip of the arytenoid cartilage.

From the whole superior margin of the thyroid cartilage included

between its greater cornua, there proceeds upwards a thin lamina of somewhat condensed cellular substance, which is attached to the inner margin of the base and of the cornua of the os hyoides their whole length. It fills completely the space between the os hyoides and the thyroid cartilage. This membrane is called the middle Thyro-hyoid Ligament (*ligament. thyro-hyoid medium*), though its ligamentous character is by no means well developed except in the middle where, according to Dr. Leidy, the yellow elastic tissue is very well seen with the microscope. It completes the periphery of the larynx in the space alluded to, and, from its thin yielding nature, presents no obstacle to the motions of the os hyoides and of the thyroid cartilage upon each other.

The posterior margin of this membrane, on each side, is bounded by a long, rounded, fibrous chord, the Lateral Thyro-Hyoid Ligament (*ligamentum thyro-hyoideum laterale*). The latter is extended from the cornu major of the thyroid cartilage to the tuberculated extremity of the os hyoides, and frequently contains, about its centre, a small oval cartilage or bone (*cartilago triticea*), not quite so large as a grain of wheat.

Immediately under the body of the os hyoides, between its concave face and the middle thyro-hyoid ligament, is a small sac or cell formed between the laminæ of this ligament, and frequently extending itself downwards as far as the notch of the thyroid cartilage; it is flat, about four or five lines in its transverse diameter, and presents a shining surface. I have never seen a fluid in it in the natural state: its secretion, however, sometimes becomes excessive, and it is then elongated downwards over the front of the thyroid and of the cricoid cartilage, as far as the isthmus of the thyroid gland. In this state it frequently forms a small fistulous opening, at its lower end, through the skin; and which is marked by a fold of the latter across the neck. The true pathology of the disease was first pointed out by the late Dr. Physick, who cured it, in some cases, by the introduction of lunar caustic, and in others by extirpation.

The lateral Crico-Thyroid Ligament attaches the Cornu minus or inferior horn of the thyroid cartilage to the side of the cricoid; its fibres are strong and shining, and there is not unfrequently, we may say generally, an articular cavity within its circle. This junction is the centre of the very limited rotatory motion of the thyroid upon the cricoid cartilage.

The interval in front between the thyroid and the cricoid cartilages is filled by a ligament adhering to its margins called the Middle Crico-Thyroid, to distinguish it from the ligamentous junction between the inferior cornua of the thyroid, and the sides of the cricoid. The middle ligament has some small apertures in it for the passage of blood-vessels and of nerves, and is made of yellow elastic tissue. It is the part commonly cut in the operation of laryngotomy.

The Thyro-Arytenoid Ligaments are two in number, on each side of the larynx; one above the other, at the distance of three lines. The inferior is extended from the anterior angle of the base of the arytenoid

cartilage to the inferior part of the entering angle of the thyroid, and, by converging towards its fellow, is inserted there in contact with it. Its fibrous structure is very distinct. It also bears the name of vocal chord (*ligamentum vocale*), from its bordering the rima glottidis. The superior thyro-arytenoid ligament arises from the middle of the anterior edge of the arytenoid cartilage, and is also inserted into the entering angle of the thyroid; it is more distant from its fellow than the lower one is, and goes almost parallel with it; so that the opening between the two upper is both larger and more like an oblong, than it is between the two lower. Its fibrous structure is less distinct than that of the lower, and is by some denied wholly. Both the upper and the lower ligaments are covered by a reflection of the lining membrane of the larynx, and are small, round bands, which are rendered more or less tense by the action of the small muscles of the larynx.

The superior thyro-arytenoid ligament is attached, as previously stated, in its whole length, by a triangular fibro-muscular layer to the pedicle and side of the epiglottis: the posterior margin of this layer is distinctly muscular, and must have the effect of drawing the ligament upwards, hence this ligament is in an arched line.

Lauth has described a band of radiating elastic fibres which leaves the thyroid cartilage, between the vocal chords, and expands so as to be attached to the superior margin of the Cricoid cartilage,—to the middle crico-thyroid ligament,—to the arytenoid cartilage and its articulation, and also to the lower and upper thyro-arytenoid ligaments.[1]

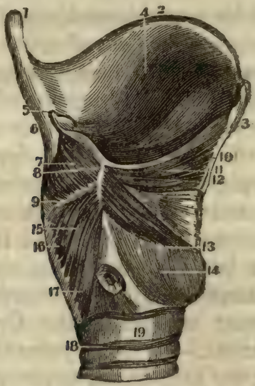
Müller[2] considers that it is also extended over the outer face of the ventricle of the Larynx. The observations of Dr. Leidy go to show that neither the upper nor the lower thyro-arytenoid ligament is more than a doubling or simple fold of this ligamentous expansion described by Lauth, and that it may be more judiciously viewed as an extension of the middle crico-thyroid ligament. In this case the best description, probably, will be to say that the middle crico-thyroid ligament, having made its attachments to the contiguous margin of the cricoid and thyroid cartilages, and passed some distance up along the entering angle of the thyroid cartilage, expands then in a fan-like manner to have the inferior margin attached along the whole upper edge of the cricoid cartilage—the posterior edge attached along the anterior margin of the arytenoid cartilage and corniculum—and the superior margin along the whole lateral border of the Epiglottis. Thus connected, it is immediately subjacent to the mucous membrane of the larynx, and consequently makes the exterior layer to the ventricles of the larynx. As it is everywhere formed of yellow elastic ligamentous tissue, its extensibility and contractility make it highly useful to the voice, and we may readily understand that its folds making the vocal chords or thyro-arytenoid ligaments, have the sharpness of their free edge regulated by the degree of distension with air of the laryngeal ventricles. A very strong distension of the latter must sharpen the edge of the superior ligament, and assist in forming the higher notes, which are lost entirely in tumefactions of the mucous

[1] Huschke, Traité de Splanch. p. 224, Paris, 1845.
[2] Physiology, p. 1005.
[3] See Encycl. Anat. p. 434, vol. vi.

membrane from inflammation, or when the laryngeal ventricles are closed as in croup by the secretion of a plastic membrane on their surface, and that of the larynx generally. In this view, this entire membranous expansion may with propriety attain to a distinct name, as, for example, the *Phonetic* or *Vocal Membrane*, which for perspicuity may be divided into the cricoid or inferior part—the arytenoid, middle, or vocal part—and the epiglottic or upper part.

There are several pairs of muscles belonging to the larynx.

Fig. 209.



A vertical section of the Larynx to show some of its Muscles.—1. Cornu majus of the thyroid cartilage. 2. Its superior border. 3. Section of its body. 4. Its internal surface. 5. Arytenoid cartilage. 6. Posterior margin of the thyroid cartilage. 7, 8. Oblique and transverse arytenoid muscles. 9. Crico-arytenoid articulation. 10, 11, 12. Thyreo-arytenoid muscle. 13. Crico-arytenoideus lateralis. 14. Cricoid cartilage. 15, 16, 17. Crico-arytenoideus posticus. 18, 19. First two rings of the trachea as united by ligament. The right half of the thyroid cartilage has been removed.

1. The Thyro-Hyoideus, as observed in the former account of this muscle, looks like a continuation of the sterno-thyroideus. It arises, obliquely, from the side of the thyroid cartilage by the ridge, there; and running upwards, it is inserted into a part of the base, and into the anterior half of the cornu of the os hyoides.

When the thyroid cartilage is fixed, it draws down the os hyoides; but when the latter is fixed, it draws up the thyroid cartilage.

2. The Crico-Thyroideus arises, tendinous and fleshy, from the anterior lateral surface of the cricoid cartilage, and passes upwards and backwards, to be inserted into the inferior cornu of the thyroid cartilage, and into the adjacent part of its inferior edge.

Use, to draw these cartilages obliquely together by diminishing the crico-thyroid interval.

3. The Crico-Arytenoideus Posticus arises from the back of the cricoid cartilage, occupying its excavation, and is inserted into the external posterior part of the base of the arytenoid cartilage.

It draws the arytenoid backwards, and makes the ligaments tense.

4. The Crico-Arytenoideus Lateralis arises from the side of the cri-

coid cartilage along its upper margin, and is inserted into the side of the base of the arytenoid.

Use, to draw the latter outwards, and open the chink of the glottis.

5. The Thyro-Arytenoideus arises from the posterior face of the thyroid cartilage, near its angle, and from the middle crico-thyroid ligament, and is inserted into the anterior face of the arytenoid cartilage.

Use, to relax the ligaments of the glottis.

6. The Arytenoideus Obliquus arises from the base of one arytenoid cartilage, and is inserted into the tip of the other. It is a very small fasciculus, and sometimes only one muscle exists.

Use, to close the chink of the glottis.

7. The Arytenoideus Transversus is always a single muscle, which arises posteriorly from the whole length of one arytenoid cartilage, excepting a little part of the tip, and is inserted, in a corresponding manner, into the other. It fills up the cylindrical concavity of the arytenoid cartilages.

Use, to close the chink of the glottis.

8. The Thyro-Epiglottideus consists in a few fibres, and arises from the posterior face of the thyroid cartilage near its entering angle. It frequently stops short of the Epiglottis, and generally looks like a diverging fasciculus of the Thyro-arytenoideus. It is inserted into the side of the epiglottis.

Use, to draw the epiglottis downwards.

9. The Aryteno-Epiglottideus consists also in a few indistinct fibres, and arises from the superior lateral part of the arytenoid cartilage. It is inserted into the side of the epiglottis, but frequently falls short of it from imperfect development.

Use, to draw the epiglottis downwards.

These last two muscles are generally so small and undefined, that they cannot be distinguished from the adjacent soft parts without close examination.

The Interior Face of the Larynx is lined by a mucous membrane, continuous above with that of the mouth and pharynx, and below with that of the trachea. Where it is reflected from the base of the tongue to the epiglottis cartilage, it forms, as described, a well-marked vertical fold or frænum (*lig. glosso-epiglot.*) in front of the middle of the latter. On each side of this middle fold there is another (*lig. hyo-epiglot.*), not so distinct, but varying in different subjects. Beneath the middle fold is a strong fibro-muscular connection with the root of the tongue.[1] The three folds form two pouches in front of the epi-

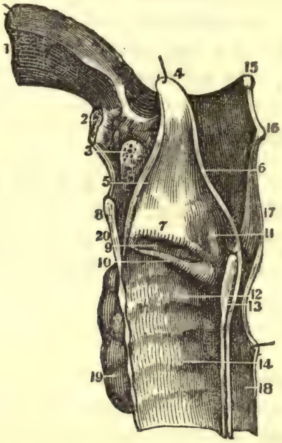
[1] A muscle of a triangular shape has been observed by the English anatomists,* situated in front of the epiglottis, passing to it from the whole concavity of the base of the os hyoides;

* Am. Med. Journ. vol. v. p. 475, from Lond. Med. Gazette.

glottis, in which food is sometimes lodged. The mucous membrane also forms the duplicature on each side, already alluded to, which passes from the lateral part of the epiglottis cartilage to the arytenoid of the same side of the body. This duplicature forms the superior boundary of the cavity of the larynx, and is very soft and extensible, permitting freely the epiglottis to be depressed and to rise again into its vertical position. The duplications of the two sides, taken together, form an oblong oval opening into the larynx, passing very obliquely upwards and forwards to the epiglottis, and terminated behind by a notch (*incisura glottidis*) between the cornicula laryngis. At the latter place the mucous membrane is wrinkled and loose, so as to permit, by its extensibility, free motion to the arytenoid cartilages.

After adopting the preceding arrangement, the lining membrane of

Fig. 210.



Middle vertical section of the Larynx—the internal surface.—1. Section of the root of the tongue. 2. Os hyoides. 3. Epiglottic gland. 4. Top of the epiglottis cartilage. 5. Its middle section. 6. A fold of mucous membrane from the arytenoid to the epiglottis. 7. Superior thyr. aryt. ligament. 8, 20. Section of thyroid cartilage. 9. Ventricle of Galen or Morgagni. 10. The vocal ligament. 11. Arytenoid cartilage. 12. Inside of the cricoid cartilage. 13. Its posterior portion. 14. Lining membrane of the trachea. 15. End of the cornu majus of the os hyoides. 16. Cornu majus of the thyroid cartilage. 17. Mucous membrane of the pharynx. 18. Œsophagus. 19. Thyroid gland.

the larynx passes downwards; it covers smoothly the posterior face of the epiglottis, adhering closely to it; but, when it reaches the thyro-arytenoid ligaments, it is tucked in between the upper and the lower one, so as to form, on either side, an oblong pouch, the bottom of which is broader than its orifice between the ligaments. This pouch is the ventricle of Galen, or of Morgagni, or of the larynx; it projects into the fatty glandular matter on the interior face of the thyroid cartilage, and has its base resting on the thyro-arytenoid muscle. Its superior end reaches almost as high as the upper margin of the thyroid

it is called Hyo-Epiglottideus. Its existence is not uniform, and in my own dissections, for the purpose of ascertaining, it has not occurred. Albinus, Sœmmering, and others, speak of the occasional existence of muscular fibres there. A strong muscle is found there in the lower animals, as stated in the description of the tongue, Vol. I.

cartilage, and it has some small fasciculi of muscular fibres on its belly which seem appropriated to its use. This pouch is in fact divided into two, an upper and a lower; the lower is oblong and horizontal, being between the thyro-arytenoid ligaments; the higher portion is a compressed spheriform sac, and communicates with the lower by a narrow neck. The continuation of the lining membrane of the Larynx afterwards lines smoothly the cricoid cartilage, and abounds there in mucous follicles.

On the posterior face of the thyroid cartilage, of the middle thyro-hyoid ligament, and on each side of the epiglottis cartilage, surrounding its lower part with the exception of its posterior face, there is an accumulation of cellular and adipose substance. In the lower part of this substance there are several small glandular bodies, sometimes insulated and sometimes collected together, which are considered to detach their ducts into the foramina of the epiglottis cartilage, and seem to open thereby on its laryngeal surface; they are mucous glands. This mass collectively is by some called the Epiglottic Gland.

The Arytenoid Gland, which is also muciparous, is situated in front of the arytenoid cartilage, in the duplicature of the mucous membrane which passes from the side of the arytenoid cartilage to the epiglottis. It is a small body of a grayish color, resembling the letter L, and consists in distinct grains. The vertical part of it runs along the front surface of the arytenoid cartilage, while the other part which is horizontal extends along the upper thyro-arytenoid ligament. It is supposed to have its excretory ducts opening into the larynx. It is frequently wanting.

That portion of the larynx which is formed by the thyro-arytenoid ligaments, and the pouches between them, is the structure essential to the formation of voice.[1] The opening between the two lower ligaments is the Rima Glottidis, and the space from the ligaments to the duplicature of the mucous membrane passing from the arytenoids to the epiglottis cartilage, may be termed the Glottis.

The Epiglottis Cartilage is principally useful in preventing articles of food from falling into the glottis, either in swallowing or in vomiting. The strength of its muscles, however, does not seem to be sufficient to draw it down over the glottis, as many physiologists suppose; on the contrary, I am induced to believe that the glottis is rather drawn upwards to it. If, on any occasion, it be depressed or bent down over the glottis, the position must be caused by mechanical pressure from the bulk of the article swallowed. But the latter explanation is not sufficient to account for the swallowing of fluids, or of a very small body, as a pill or a crumb of bread.

Impressed with these objections, and dissatisfied with the common theory, I had an opportunity, in a dissection many years ago, of witnessing a position of these parts which afforded a satisfactory explanation. The subject was a robust, muscular man, who had died suddenly. The

[1] See Philos. Trans. London, 1846, for an interesting paper, by John Bishop, Esq., on the Physiology of the Human Voice.

upper orifice of the glottis was closed and protected, but by an arrangement precisely the reverse of the received opinion; for the epiglottis, retaining its naturally erect position, with a slight inclination backwards, had the opening of the glottis drawn up so as to come in contact with its posterior face. The cricoid cartilage, as has been mentioned, slopes on its superior margin upwards and backwards; the front surfaces of the arytenoid cartilages, in their natural position, are nearly on a line with this slope, or a continuation of it; the whole may, therefore, be considered in the light of an oblique plane, rising up behind the epiglottis cartilage. By a very slight additional elevation of this plane along with the rotatory motion of the thyroid cartilage upon its lesser cornua, the plane is caused to come in contact with the posterior face of the epiglottis, and thereby to close the upper opening of the glottis.

The principal agents in this motion are the thyro-hyoid muscles, the contraction of which causing the larynx to ascend, the opening of the glottis is brought up behind the epiglottis, and thereby secured from the introduction of food into it. Whether the food be passed from the mouth into the stomach, as in swallowing, or from the stomach into the month, as in vomiting, is equally unimportant; and the security is the same, whether the article be small or large, fluid or solid. Several years ago, 1816, I dissected a gentleman who had symptoms of sore-throat, with swelling of the neck, superadded to those of pulmonary consumption: during the existence of his sore-throat, in addition to the usual difficulty of swallowing, he was frequently affected, in the act, with strangulation to an alarming and distressing degree. In the dissection, it was found that an abscess, of considerable extent, existed between the os hyoides and the thyroid cartilage, and involved the thyro-hyoid muscles. Without knowing at the time the value of this observation, I am now persuaded that the strangulation arose from the inactivity of the thyro-hyoid muscles. In some ulcerations of the epiglottis cartilage which I have had an opportunity of seeing, the upper circular portion which projects above the root of the tongue has been lost: if the accident be confined to that extent only, deglutition is not so much impaired, because still enough of the epiglottis is left to perform the office assigned to it, as the upper part is less essential. The cases of its reputed loss by wounds must be considered as applying themselves to this upper portion only, because a wound low enough to remove the whole body would cause such a destruction of the rima glottidis as to produce an embarrassment of respiration incompatible with life.

It is probable that the inferior constrictors of the pharynx, as well as the stylo-pharyngeal muscles, assist in this use of the thyro-hyoidei.

There is a well-marked difference in the larynx of the two sexes. In the female, it is generally smaller by one-third than it is in the male; the thyroid cartilage is also less prominent, in consequence of its two halves uniting at an angle more obtuse; the pomum Adami is, therefore, seldom conspicuous. The rima glottidis is also smaller in women.

The nerves of the larynx come principally from the superior and the inferior laryngeal branches of the par vagum.

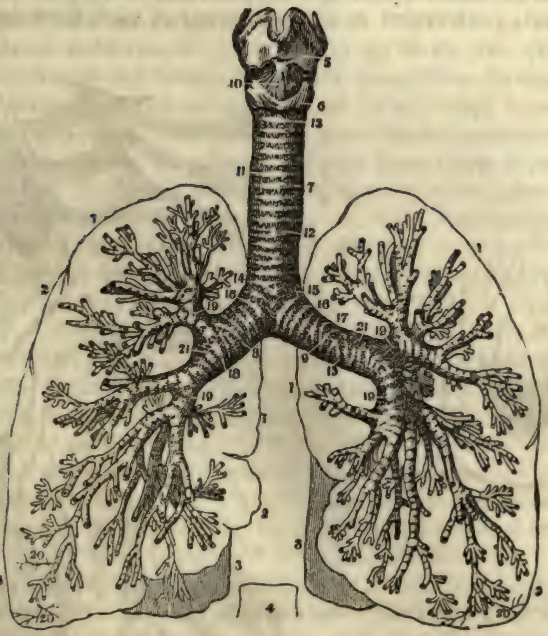
CHAPTER II.

OF THE TRACHEA, AND THE GLANDS BORDERING UPON IT.

SECT. I.—THE TRACHEA AND BRONCHIA.

The Trachea, or Aspera Arteria, is a cylindrical canal of four or five inches in length and about nine lines in diameter, communicating with the lungs for the transmission of air. It opens into the larynx above, by being attached to the inferior margin of the cricoid cartilage, by the crico-tracheal ligament, and terminates in the thorax, opposite the third dorsal vertebra, by two ramifications called Bronchi or Bronchia. In this course it is situated over the middle line of the neck, beneath the sterno-thyroid muscles, and separated from them by the deep-seated

Fig. 211.



The Larynx, Trachea, and Bronchia, with the outline of the Lungs.—1, 1, 2, 3, 3. Right and left lungs. 4. Ninth dorsal vertebra. 5. Thyroid cartilage. 6. Cricoid cartilage. 7. Trachea. 8. Right bronchus. 9. Left bronchus. 10. Middle crico-thyroid ligament. 11, 12. Rings of the trachea. 13. First ring of the trachea. 14, 15. Last ring of the trachea, which is corset-shaped. 16. Simple bronchial cartilaginous rings. 17, 18. Bifurcated bronchial rings. 19, 19. Smaller bronchial rings. 21. Difference in length and size between the right and the left bronchus.

fascia of the neck and the adipose matter beneath it. It is placed in front of the œsophagus, between the primitive carotid arteries and the

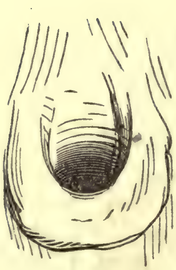
internal jugular veins. When it has got into the thorax, it inclines slightly to the right side as it passes behind the curvature of the aorta. Of its two branches, the right bronchus is larger than the other; it is also less slanting, and an inch long before it branches. It sinks below the right pulmonary artery, to penetrate the lung about the fourth dorsal vertebra. The left bronchus being two inches long, sinks into the lung of the left side, below the corresponding pulmonary artery, and opposite the fifth dorsal vertebra. The bronchia then divide and subdivide very minutely through the lungs.

Very dissimilar structures enter into the composition of the trachea; they are cartilage, elastic ligamentous fibre, muscle, and a mucous membrane.

The Cartilage preserves the cylindrical shape of the trachea, and consists in from sixteen to twenty distinct rings, which are deficient in the posterior third of their circumference. Each ring is about two lines broad, and half a line thick, and is kept apart from the one above and below it by a small interstice: sometimes, however, they run into each other.

There is an almost uniform similitude between these rings; the principal departure from which is observed in the first being rather broader in front than the others, and in the last ring, which, by its triangular shape in front, contributes to the beginning of each bronchus.

Fig. 212.


A

Semilunar Cartilages for holding open the Bronchial Branches at their orifices.—*a*, *a*. Bronchus. *b*, *b*, *b*. Orifices of branches of bronchus. *c*, *c*, *c*. The semilunar cartilage placed at the inferior semicircumference of orifice. *d*, *d*, *d*. Portions of lung contiguous. View much magnified.

A. A bronchial orifice.

The rings of the Bronchia are, like those of the trachea, deficient in their posterior third, and the same arrangement holds during their primitive ramifications in the lungs. But as they subdivide more and more,

the cartilages do not succeed each other so closely, are smaller and shorter segments of circles; they are also not regularly deficient at the posterior third; but in place of the latter, the bronchial ramification is furnished with cartilage, consisting in interspersed pieces. The pieces become more and more scattered and small, till they finally disappear, and the bronchus is simply membranous. At the orifice of each branch of the bronchia, there is a bent semilunar cartilage, forming rather more than one-half of its circumference, and having its concave edge upwards: the whole arrangement resembles somewhat the pasteboard to an eared bonnet, and is evidently to keep the orifice open.

The Ligamentous Structure of the trachea and of the bronchia is very evident between the proximate margins of the cartilaginous rings, and fills up the intervals between them so as to make the tube perfect. This tissue is of the yellow elastic kind, and may be traced over the surfaces of the rings, forming their perichondrium, so that they are imbedded in it. It does not exist in the same state, in the human subject, in the interval behind, where a third of the ring is defective; its place there is supplied by a substance of a fibrous character and intertexture, but not so condensed or elastic. In the smaller ramifications of the bronchia, where the separated little cartilaginous segments are adjusted around them, it is probable that the elastic yellow tissue contributes to the whole periphery of the ramification.

The ligamentous structure possesses great elasticity, which is manifested by the rapid shortening of the trachea, when its two extremities are stretched apart and then suddenly let loose. And it is the continuance of this quality of elasticity, in the minute ramifications of the bronchia, which proves the existence of the same tissue there, even when it cannot be very distinctly seen. The whole of this ligamentous structure of the larynx, trachea, and bronchia may, from its elasticity and from the intertexture of its fibres, be considered as one of the modifications of the yellow elastic tissue, though not so deep in color as that on the spine.

The Muscular Structure of the trachea exists at the cartilaginous deficiency in its posterior third, and consists in a thin muscular plane whose fibres pass transversely between the separated extremities of its cartilaginous rings. These transverse fibres begin at the first ring, and exist all the way down: they arise from the internal faces of the rings and their intermediate elastic ligamentous tissue; about a line beyond their extremities. Anteriorly, the muscular structure is covered by the lining membrane of the trachea, and posteriorly, by the dense fibro-cellular tissue just spoken of.

A similar arrangement of muscular structure occurs in the bronchia and for some distance into the lungs. Where the cartilages become scattered and irregular, the muscular fibres are said, by J. F. Meckel and by M. Reisseissen,[1] to perform the whole circuit of the bronchial

[1] De Fabrica Pulmonis, Berlin, 1822. M. Laennec says (Traité de l'Auscultation, Paris, 1826, vol. ii. p. 189) that he has sought in vain to verify these observations of Reisseissen, but that the manifest existence of circular fibres upon branches of a middling size, and the phenomena of many kinds of asthma, induce him to view, as a thing well established, the

ramification, and to be visible even beyond the existence of the cartilaginous pieces. Sœmmering expresses a doubt of this arrangement.[1] It is very difficult in such minute structure to arrive at a satisfactory conclusion; careful observations, latterly made, have, however, induced me to adopt the same conviction as Reisseissen. Longitudinal muscular fibres are said by Portal to exist between the contiguous margins of the cartilaginous rings, but the fact is far from being ascertained.[2]

In some subjects a very strong plane of longitudinal muscular fibres is seen going the whole length of the trachea on its posterior face: being placed just behind the transverse muscular fibres.

The use of the muscular tissue has been pointed out, by the late Dr. Physick, as follows: "In expectoration, it diminishes the caliber of the air-tubes, so that the air having to pass out with increased rapidity through them, its momentum will bring up the inspissated fluid which may be in its way." This very ingenious theory has subsequently been advanced by M. Cruveilhier, of Paris, possibly without a knowledge of his having been anticipated; but certainly not without the claims of the eminent individual to whom we owe it having been established by its publication.[3]

The Mucous Membrane of the trachea lines its whole interior periphery, from the larynx to the bronchia, and is continued, under the same circumstances, through the latter to their minute divisions. It adheres very closely to the contiguous structure, and is continued in the substance of the lungs, beyond the traces of any of the other tissues which compose the bronchia; it indeed terminates in the air-cells. It is thin, red, and very vascular, like other mucous membranes: and also, like them, the venous appears to prevail over the arterial vascularity. A successful minute injection makes it look as if it consisted of a tissue of blood-vessels: it presents, at the cartilaginous deficiency, an abundance of slightly elevated longitudinal folds: one of the latter, conspicuous for its greater size, exists at the commencement of the left bronchus, and is yet more developed in the still-born infant.

The exterior circumference of the mucous membrane is studded with Muciparous Glands about the size of millet seed. These glands are particularly conspicuous and abundant on the posterior part of the trachea and of the bronchia, where the deficiency of the cartilaginous rings is supplied by the musculo-membranous structure only; and more of them exist at the lower part of the trachea and upon the roots of the bronchia than elsewhere. They are placed behind the muscular layer, which their excretory ducts have to penetrate. Besides occupying these situations, they are found in the interstices between the edges of the cartilaginous rings, mixed up with fat granules, but here they are

temporary occlusion of the small bronchial ramifications by a spasmodic contraction of their parietes.

[1] Extimæ autem vel posticæ ejus fibræ per longitudinem, a cartilagine cricoidea ad pulmones usque descendunt ac, vel in ipsis tracheæ ramis haud parum conspicui sunt.—De Corp. Hum. Fabrica.

[2] Anat. Med.

[3] Wistar's Anatomy, 3d edition, vol. ii. p. 64, Phil. 1821.

much smaller. The mucous membrane abounds so much in the orifices made by their excretory ducts that it looks cribriform, which appearance is increased by floating it in water.

About the origins of the bronchia, there is a considerable number of black-colored lymphatic glands, called Bronchial, which it is easy to distinguish from the preceding by their color and much greater size.

There are two more glands of a different character, which, though they do not enter into the composition of the trachea, yet, from their locality, are most conveniently studied at this time: they are the Thyroid and the Thymus.

SECT. II.—OF THE THYROID GLAND.

The Thyroid Gland (*glandula thyroidea*) is placed on the first and second rings of the trachea, and on the sides of the larynx.

It consists in a middle portion—which is thin, of variable magnitude in different individuals, sometimes entirely wanting, and which, being stretched across the upper part of the trachea just below the larynx, is called its isthmus—and of two lobes, one on each side, which, being flattened and ovoidal, are extended considerably upwards on the side of the larynx, and downwards on the side of the trachea and of the œsophagus. Frequently from the superior part of the isthmus, and most commonly on its left side, a small pyramidal process runs upwards in front of the cricoid and of the thyroid cartilage, and is attached, by ligamentous and occasionally a few muscular fibres, to the os hyoides; this process, however, varies much in size and length; I have never seen it double. According to Morgagni and Meckel, the existence of this process is much more common than its absence, which corresponds, variety of size being admitted, with my own observations. The thyroid gland, when extended, measures about three inches from side to side.

It is covered in front by the sterno-hyoid and thyroid muscles, and laterally by the omo-hyoid and the sterno-mastoid. Embracing the trachea and the sides of the larynx, its lobes repose upon the primitive carotids, and the internal jugular veins.

The thyroid gland has a capsule which is not very easily raised up, but serves to give it a polish; it is also invested by the condensed cellular membrane of the part called fascia profunda colli. Its surface is smooth and uniform. It is of a dark brown color. When cut into or torn, it is seen to consist of several lobules adhering to each other; but this arrangement is not very distinct, except in an enlarged or diseased state; and may be traced most easily by following the course of the large blood-vessels, which pass in the interstices between the lobules. The latter contain many small vesicles, or cells filled with a transparent or yellowish and somewhat unctuous fluid: the cells are frequently in a collapsed state, which prevents them from being manifest to the naked eye. According to the observations of Mr. Simon,[1] these vesi-

[1] Phil. Trans. 1844.

cles are completely closed, being formed by a delicate homogeneous membrane, invested by a close capillary net-work. Intermixed with their contained fluid, are cytoblasts which float freely about in it. These are found frequently as the nuclei of cells, of the diameter of $\frac{1}{1400}$th of an inch.

There are four considerable arteries which supply this body, two on each side, one coming from the external carotid, and the other from the subclavian. The veins follow the course of the arteries for the most part. Bichat has made a very interesting remark on the subject of its blood-vessels; that, notwithstanding their size and number, and minute ramifications in it, much less blood remains in its capillary system than in that of the liver or kidney, as is proved by the quantity of water it tinges in maceration; he, therefore, infers that the capillary system is less abundant.

Anatomists have sought in vain for one or more excretory ducts to this body, and some have imagined that they had found them terminating in the trachea, or in the larynx. Santorini considered the pyramidal process from the isthmus as the desired duct. The emphysema with which the gland has sometimes been affected was supposed to be a proof of its communicating with the trachea by excretory tubes: but it is more probable that the air was forced into the cellular substance, uniting its lobules, and not into the structure itself of the gland.

The settled opinion now seems to be that whatever fluid it secretes is conveyed away by the lymphatic vessels. Meckel has suggested, that as this gland is more voluminous proportionately in early infancy, particularly its pyramidal process, possibly the duct may be obliterated when the gland begins to be restrained in its growth; but, if this were the case, the duct ought to have been found during the period indicated. The probability is, that it is a diverticulum of blood from the salivary glands during the intermittence of their action; and from the marked sympathy between it and the brain in goitre, it may exercise a corresponding function on this organ during its intervals of repose.

Duverney[1] has described a small azygous muscle on the middle line of the body, coming from the under margin of the base of the os hyoides, and running over the middle of the thyroid cartilage, to be inserted into the upper margin of the isthmus of the thyroid gland. Sœmmering calls it Levator Glandulæ Thyroideæ, and speaks of it as being found more frequently on the left side, and about half of the breadth of the thyro-hyoideus. After many special examinations for it I have found it in but few instances; I, therefore, consider it rare; though without a close attention to structure, the pyramidal process of the isthmus of the gland may, from the similitude of color and position, be very readily mistaken for it, which I have reason to believe has been frequently the case.[2] Some few fibres are often found going to the

[1] Essai D'Anatomie en tableux imprimés, pl. iv. Paris, 1745.

[2] The unassisted eye, in a strong light, is generally sufficient to determine the structure; but in case of doubt, by boiling the gland, if there be muscular fibres along this process their longitudinal and parallel direction will become evident; they also may then be torn asunder, so as to be made still more distinct; whereas, the vesicular structure of the gland is not susceptible of division into fibres.

isthmus of the gland from the crico-thyroid, and the thyro-hyoid muscles, or from the thyroid cartilage.

SECT. III.—OF THE THYMUS GLAND.

This body (*glandula thymus*) is placed between the trachea and the upper extremity of the sternum. It is irregularly triangular, its broadest part being above, and the narrower below. In the adult, it is in a collapsed and shrivelled state, and scarcely presents a vestige of what it once was; it is, therefore, only in the infant that it can be satisfactorily studied.

Fig. 213.

A section of the Thymus Gland at the eighth month.—1. Cervical portion of the gland. 2. Secretory cells seen upon its surface. 3. The pores or openings of the cells or pouches.

At birth, it is much larger, not relatively, but actually, than it is in the adult, and extends from the body of the heart up to the thyroid gland. It is of a very soft consistence and of a pink color. It is surrounded by a capsule of cellular substance, which, when removed, permits the gland to be resolved into two lobes, one on either side, which adhere to each other. These lobes may be separated with facility into lobules, which contain a whitish, cream-like fluid.

A good essay on the structure of this gland has been published by the distinguished British surgeon and anatomist, the late Sir Astley Cooper,[1] illustrated by excellent plates. From this it appears that the lobules of the gland are formed of vesicles of various sizes, discharging into pouches at the base of the lobules, and they again discharge into a duct or common reservoir, which runs from one end of the gland to the other, the consistence of which duct is extremely feeble. This duct, the pouches, and the vesicles, may be filled with an injection by means of a pipe introduced into the substance of the gland. A large lymphatic trunk passes from the gland, on each side, into the transverse vein near its junction with the vena innominata of the right side, or at the junction itself.

[1] London, 1832.

The observations of Sir Astley Cooper have been confirmed, in their main features, by those within two or three years past of Dr. Oesterlin of Jena, and of Mr. Simon of London, who also asserts that the cream-like fluid of the vesicles is mixed with a multitude of corpuscles, having the structure and relations of nuclei. Many of the corpuscles are circular, but others are flat and disk-like. Their average diameter is about the $\frac{1}{3833}$th of an inch, and they are characteristically dotted with from two to five very small dark spots, which are either collected or dispersed.[1]

Sir Astley thinks, or, rather, asks, whether this gland does not prepare a fluid for fœtal nourishment, in the absence of proper chylification, during fœtal life? inasmuch as all the elements of the blood are, upon chemical analysis, found in the fluid contained in its cavities. This opinion is now gaining ground in regard to all of the simply vascular glands, as the Thyroid, the Thymus, the Supra-Renal, and the Wolffian.

It is visible in the third month of gestation, and continues to grow till the end of the second year of extra-uterine life. It then collapses, and its structure is effaced about the twelfth year; its remains are scarcely distinguishable subsequently from the surrounding cellular substance. It is stated by Krause[2] that, in almost all individuals of from twenty to thirty years of age in whom he has examined the condition of this gland, it was still existing, and in some instances larger than in children; and that in persons of from thirty to fifty years he had found it of considerable size. It has latterly happened to me to see it in several persons of from twenty to thirty years old, forming an oblong oval body, two inches or more long by twelve or fifteen lines wide, and preserving its characteristic structure and division into lobes and lobules. No excretory duct has been found for it, unless we may consider as such the lymphatic trunk alluded to by Sir Astley Cooper. Though it clearly belongs to fœtal and infantile existence, its use is problematical. The probability is that it is a diverticulum of blood from the lungs during their state of quiescence in fœtal life, and until their structure becomes confirmed and proportionately evolved.

CHAPTER III.

OF THE LUNGS.

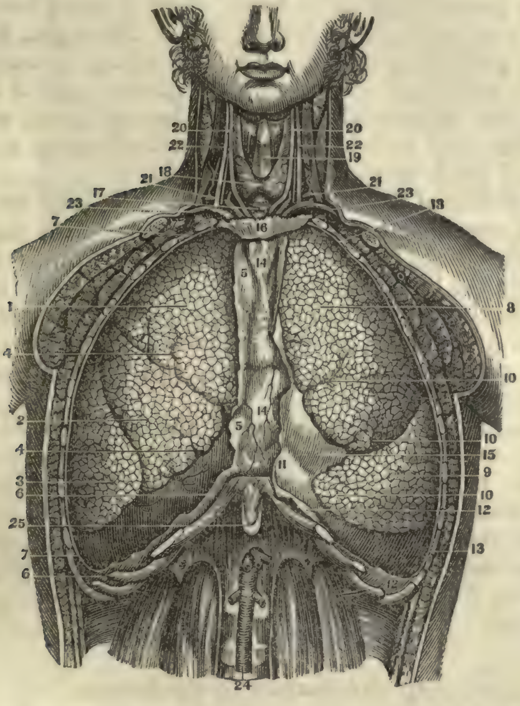
The Lungs (*Pulmones*) are the essential seat of the process of respiration, and occupy the greater part of the cavity of the thorax, as formed by the ribs and the intercostal muscles on the sides; by the sternum and its cartilages in front; by the dorsal vertebræ behind, and by the diaphragm below. They are two bodies, placed one on either side of the thorax, and separated from each other by the heart and

[1] Br. and For. Med. Review, April, 1846.

[2] Müller's Physiology, p. 622.

its great vessels. As the heart is the only organ of much volume which is also included in the cavity of the thorax, the size of the lungs is in a direct relation with the capacity of the latter, and may, therefore, be known by external indications in the living body. It is probable that there is no void, or only a very small one, between the sides of the lungs and the sides of the thorax.

Fig. 214.



An anterior view of the Thoracic Viscera.—1. Superior lobe of the right lung. 2. Its middle lobe. 3. Its inferior lobe. 4, 4. Lobular fissures. 5, 5. Layer of pleura forming the right side of the anterior mediastinum. 6, 6. The diaphragmatic portion of the right pleura. 7, 7. The right pleura costalis. 8. Superior lobe of the left lung. 9. Its inferior lobe. 10, 10. Interlobular fissures. 11. The portion of the pleura which forms the left side of the anterior mediastinum. 12. The diaphragmatic portion of the left pleura. 13. Left pleura costalis. 14, 14. The middle space between the pleuræ, known as the anterior mediastinum. 15. The pericardium. 16. Fascia profunda cervicis. 17. The trachea. 18. Thyroid gland. 19. Anterior portion of the thyroid cartilage. 20. Primitive carotid artery. 21. Subclavian vein. 22. Internal jugular vein. 23. Brachio-cephalic vein. 24. Abdominal aorta. 25. Xyphoid cartilage.

Each lung forms an irregular cone, the apex of which is above, and the base below; the latter, from resting upon the diaphragm, is consequently oblique from before backwards and downwards, and is also concave. The surface which reposes against the periphery of the side of the thorax is uniformly rounded; but that which looks towards its fellow is concave, from being pressed in by the heart. The vertical diameter of the lung behind, when it is fully distended, goes from the head of the first to that of the last rib, and is, from the oblique direction of the diaphragm, consequently, much more considerable than the vertical diameter in front, which extends only from the first rib to the inferior end of the second bone of the sternum, or, in other words, to a level with the tendinous centre of the diaphragm.

The lungs of the adult are of a light pink color, with specks or patches of black; in early life there is much less of the latter, and in advanced life it becomes more abundant.

The left lung is divided into two lobes by a deep fissure, which begins behind, on a level with the fourth dorsal vertebra, and runs obliquely downwards and forwards to the anterior margin of its base. A deep fissure in a nearly similar situation is observed on the right lung; but from it another fissure branches out forwards, by which the right lung is divided into three lobes. The internal face of the left lung is also much more concave than that of the right, from the side of the heart projecting into it. The right lung is more voluminous than the left, which corresponds with the greater size of the bronchus on this side, but its vertical diameter is not so great, owing to the pressure of the liver from below; though this diameter is increased by the descent of the liver when we are upright.

Near the middle of the internal face of each lung are to be seen the points of connection with the bronchus, and with the pulmonary vessels. Before these the anterior margin is thin, and more or less winding where the lung is introduced between the heart and the front parietes of the thorax. When the lungs are fully inflated, only a very small portion of the front of the pericardium can be seen between them. The posterior margin is thick, and rounded where it rests against the vertebral column.

The whole rounded circumference of the lung as well as its base, though they are in contact with the parietes of the thorax, do not adhere at any point to them. The connection of the lung, constituting its Root, as it is called, and by which it is maintained in its situation, is entirely on the side of its concave face, where the pulmonary vessels and bronchus enter, and though other attachments are frequently found springing from different points of the thorax, they are purely the results of disease.

Of the Texture of the Lungs.

Each lobe of the lungs is divided into a great many distinct lobules, which adhere together by intermediate cellular tissue. The marks of these divisions are apparent on the surface by lines running in different directions, but they are made still more distinct by tearing them asunder. The Lobules are subdivided into very fine air-vesicles or cells, which may be considered as the dilated terminations of the ultimate branches of the bronchia, with the same structure of an elastic and of a mucous membrane. The opinion is generally held that the cells do not communicate laterally with one another as the cells of the bones, but only with the ramifications of the bronchus, to which they respectively belong. Numerous observations, however, have induced me to abandon this idea, and to conclude that the cells of the lobules individually communicate, but not those of different lobules. I have succeeded in proving this by distending the air-cells with tallow, and, after the lung was dried, removing the tallow with spirits of turpentine. This process shows the cells of their natural size, and communicating freely. A very small portion of a lung of either the human

subject or the calf, kept inflated and dried, shows the same unequivocally.

Fig. 215.

A magnified view of a section of the Lung, showing the arrangement of some of the Lobules, the communication of the Air-Cells in one Lobule, and their separation from those of the adjoining Lobule. The ramifications of the blood-vessels in the texture of the lung, and their course through the air-cells, are also seen.—1, 1. Branches of the pulmonary veins. 2, 2. Branches of the pulmonary artery.

The most prevalent opinion, however, of the day is that derived from Willis originally, that the air-vesicles have the same relation to the bronchioles that the berries have to the stem in a bunch of grapes. This idea has been reiterated by Reisseissen,[1] and his plates fallaciously taken as the standard of structure, in the anatomical works generally. It has also been re-asserted, still more lately, by Huschke, under the declaration of the opposite being the reproduction of an ancient error.[2] On the contrary, my opinion, sustained by numerous anatomical preparations, may be traced as far back as Helvetius and Duverney, and has, as its advocates, Haller, Sœmmering, J. F. Meckel, and Cruveilhier. The doctrine is, moreover, decidedly advocated, with some modified views, in regard to the shape of the cells, by J. M. Bougery, an anatomist now well known for his splendid anatomical plates. The leading peculiarity of his views is that the cells, though they communicate freely, are yet canalicular,[3] that is, they have the measurement of length exhibiting great excess over every other, in which I do not agree with him. The intercellular communication is also strongly illustrated by the observations of Mr. Rainey, a recent writer on the subject.[4] If indeed the larger and more visible of the bronchial tubes require a semilunar cartilage at their orifices, as I have indicated, to keep them from collapsing, it would scarcely be possible for respiration to go on if each cell was in the necessity of being filled through its own special bronchiole, as asserted by many.

[1] De Pulmon. Struct. 1803.
[2] Traité de Splanch. p. 249, Paris, 1845.
[3] Gazette Méd. de Paris, July, 1842.
[4] Med.-Chirurg. Transactions, 1845.

In tracing the terminations of the bronchi, in the substance of the lungs, the parietes of these canals are observed to become very thin, and especially after the cartilaginous structure has ceased. The ramifications or bronchioles seem then to be composed almost entirely of a filamentous coat, lined with a delicate mucous membrane.

The filamentous coat is, no doubt, an extension of the membranous portion existing so conspicuously on the back of the trachea and bronchia, and connecting the cartilages by their ends, and it retains the extensibility and contractility of the same. Its filaments are principally in a circular direction, and resemble so strongly muscular fibres that they alone seem to exist. It is, however, more probable that, exterior to these, we have a fine elastic ligamentous layer, or it may be blended with them, it being difficult to distinguish, where there is such a sameness of color, the one tissue from the other. Some anatomists have, indeed, considered it all as of an elastic ligamentous character, in which case, the circularity of the fibres may be compared to the same condition in the internal layer of the corpus cavernosum penis.

The lining mucous membrane of the bronchia is smooth, polished, and so thin that it is a mere film, about the thickness and transparency of the peritoneum, where it covers a small intestine. Longitudinal folds may be traced in the length of this mucous membrane for some distance down the bronchia, indeed as far as the cartilaginous segments of circles appear, and even into the finer branches. With the aid of a lens, mucous follicles are very perceptible in innumerable quantities all over it. It may also be remarked that the bronchia do not end by a regular succession of proportionately finer and finer branches; but that a bronchial trunk, of some lines in diameter, sends off in different directions to the contiguous lobules, branches about the size of a bristle, which are followed with much difficulty, owing to their collapsing; the probability is, however, that each one of these branches belongs to a lobule, and discharges into its cells, in a manner resembling a blowpipe fixed to the side of a small piece of sponge. In my preparations, these terminating tubes of the bronchia, the size of bristles, are seen very distinctly; but there is no appearance of the penicillous or brushlike arrangement, which would be apparent if each cell had its own special branch of the bronchus running to it.

The internal surface of the lung, owing to this multiplication of it by cells, may be considered as a vast area obtained in a very small space, and containing a close intertexture of the most minute capillaries, for the purpose of exposing the blood to the process of respiration.

There is no absolutely uniform size for the air-vesicles, but their diameter may be stated as from near the two-hundredth part to the fiftieth of an inch—say from the sixteenth to the fourth of a line. Weber says from the $\frac{1}{199}$th to $\frac{1}{169}$th. The capillary blood-vessels have an extremely attenuated distribution over them; leaving scarcely anything like regular interstice; these capillaries are, in their own diameter, about the twentieth part of the diameter of the smaller air-vesicles.

The readiness of pulmonary hemorrhage is a sufficient proof of the facility with which blood passes from the blood-vessels into the air-vesicles and bronchial tubes. An opposite line of communication from the air-vesicles into the pulmonary blood-vessels has attracted my attention, and been the subject of several experiments, which prove

conclusively the certainty of the fact. These experiments show that water or air may be injected into the air-passages of the lungs, and returned by the pulmonary veins and the pulmonary artery, but with especial freedom through the pulmonary veins.[1] Whether this is by an absolutely direct communication, or by the intervention of the lymphatic system, I cannot at present determine; but my inclination is in favor of the first. It may, however, be stated that it is a matter of common experience with anatomists to inflate the pulmonary lymphatics from the air-vesicles; also to inject the pulmonary lymphatics from the bronchial arteries; and therefore the communication of the air-vesicles with the blood-vessels may be by this series of anastomoses; that is, going from the air-vesicles to the lymphatics, and from them into blood-vessels, which all communicate freely with one another.

Besides the ramifications of the bronchia, the substance of the lungs is composed of numerous blood-vessels and of lymphatics, and is well supplied with nerves.

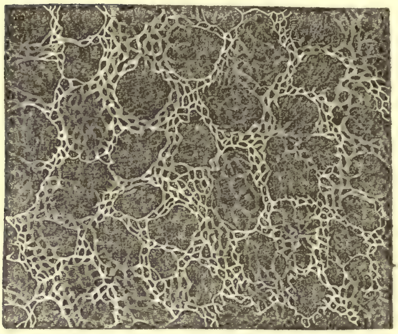
The blood-vessels are of two kinds: the pulmonary and the bronchial. The pulmonary artery, coming from the right ventricle of the heart, divides under the arch of the aorta into two large branches: one for the right lung, and the other for the left. The right branch is larger than the left. Each of these branches, having reached the upper part of the root of its respective lung, begins there to distribute itself in large trunks, which divide and subdivide throughout the substance of the lung. The terminating branches finally become capillary, and ramify in the parietes of the air-cells, where the blood which they carry, from being dark-colored and venous, is so altered as to have the arterial qualities restored to it, and to become of a bright red. From the ultimate branches of the pulmonary artery, arise the first branches of the pulmonary veins. These are successively accumulated into two large trunks on each side, which, issuing at the lower part of the root of the lung, go to open into the left auricle of the heart. It has been remarked by Mr. Boyer that the two pulmonary veins are less capacious than the pulmonary artery of the same side, in which they manifest a peculiarity of blood-vessels, differing from what exists in other parts of the body. The pulmonary artery and veins are distributed in company with the bronchus. From the observations of Professor Mayer, it appears that valves exist in the pulmonary veins, contrary to the general opinion of anatomists. They are found where smaller trunks join the larger ones, at an acute angle; but there are none where they join at a right angle.[2]

The second order of blood-vessels, being the bronchial, also consists in arteries, and in veins, and are for the nourishment of the lungs. They, too, attend the branches of the bronchus. The bronchial arteries pervade the substance of the lung by innumerable fine branches, and anastomose with the pulmonary arteries. The bronchial veins also anastomose with the pulmonary veins, but, finally, come out in small trunks from the root of the lung; the right one empties into the vena azygos, and the left into the trunk of the superior intercostal veins of the left side about the third dorsal vertebra.

[1] For the details of Experiments, see Am. Journ. Med. Sc. p. 332, April, 1843.

[2] Am. Med. Jour. vol. iii. p. 186.

Fig. 216.



Arrangement of the Capillaries of the Air-Cells of the Human Lung.

The Lymphatics of the lungs are numerous; after traversing the black bronchial glands, those of the left side empty into the thoracic duct, and those of the right into the large lymphatic trunk coming from the upper extremity.

The nerves come principally from the par vagum. Some of them are distributed with the bronchus, and may be traced easily far along its branches, forming beautiful anastomoses around them: their texture there resembles much that of the sympathetic: they are thought to be finally spent upon the mucous membrane: others seem to be more specifically appropriated to the blood-vessels.

Root of Lung.—It will now be understood that the root or adherent part of each lung is formed by a pulmonary artery, two pulmonary veins, and a bronchus, covered by the pleura, where the latter extends from the lung to the pericardium. The relative situation is such that the pulmonary artery is above, the bronchus in the centre and behind, and the pulmonary veins below.

The texture of the lung is so light and spongy after an animal has once breathed, that its weight is very inconsiderable when compared with its volume. Its cells are left much distended, even when the animal is dead; and, notwithstanding, from its unusual elasticity, it expels a great quantity of air when the thorax is opened, and is thereby reduced to a third of its size during life, yet it retains enough air to make it float in water, or even in spirits of wine. The quantity of air which the lungs contain differs very considerably in different individuals, depending entirely upon the capaciousness of the thorax. Its medium amount is computed at one hundred and forty-five cubic inches, thirty cubic inches of which are changed at every act of respiration.

Of the Pleuræ.

Each lung has a perfect covering of a serous membrane, called Pleura, to which it is indebted for its shining surface. This membrane is also reflected from the internal face of the lung to the adjacent side of the pericardium, and is then spread over the interior periphery of that half of the thorax to which it belongs, by lining the ribs and in-

tercostal muscles, and covering the convex face of the diaphragm. There are, therefore, two pleuræ, each of which is confined to its appropriate half of the thorax, so as to line its cavity and to cover its lung. The pleura can be easily torn from a lung kept in spirits of wine. It adheres by an areolar tissue without fat and having in it some yellow elastic fibres.

The pleura, as other serous membranes, is a thin sac. Its circumference is entire, like that of an inflated bladder; there is, therefore, no point or line at which one may exclusively begin an account of its course and attachments. To commence, however, at the sternum; the pleura goes thence outwardly to line the lateral parietes of the thorax, as formed by the cartilages of the ribs, the ribs themselves, and the intercostal muscles. In this way it may be traced around to the dorsal vertebræ, and over the convex surface of the diaphragm. In proceeding along the first rib, which is very oblique, it forms a sort of bulging bag, which projects towards the trachea, lines the lower part of the scalenus anticus muscle, and receives the upper extremity of the lung. The pleura, having reached the dorsal vertebræ from the ribs, passes from their sides forwards to the posterior part of the pericardium, a very small portion of which it covers. It then goes upon the posterior face of the pulmonary vessels and of the bronchus to the lung, and applies itself closely to the latter. It then covers the part of the lung posterior to its root, and continues to advance along the rounded surface of the lung to its anterior margin: it then passes over the internal surface of the lung, which is anterior to its root. It afterwards covers the front of the pulmonary vessels and of the bronchus, and gets in a very short space to the pericardium. It then passes forwards on the side of the latter, and, having got near its middle line, goes from it to the sternum, and reaches the line from which the description of its course commenced.

There is no important difference between the two pleuræ, either in their mode of reflection, or in the organs to which they are attached, so that the description of one will apply to the other. The portion of each pleura covering the lung is called Pleura Pulmonalis, and that portion which lines the thorax is the Pleura Costalis; that covering the Diaphragm is the Pleura Diaphragmalis. A duplicature of the pleura commences at the inferior margin of the pulmonary veins, and, descending as far as the diaphragm, attaches the inferior portion of the posterior margin of each lung to the side of the pericardium in front of the vertebræ. This duplicature is the Ligamentum Pulmonis. It is longer on the left lung than on the right, by reason of the greater vertical diameter of the former.

From what has been said it will now be readily understood, that the whole cavity of the thorax is divided vertically into two halves, by that portion of the two pleuræ which advances from the spine towards the sternum. This septum is called the Mediastinum, and the heart, enveloped by the pericardium, is placed in its centre, and separates the two pleuræ widely apart. It has been found useful by anatomists, for descriptive purposes, to subdivide the mediastinum into three portions or regions. One passing from the front of the pericardium to the posterior face of the middle line of the sternum, is the Anterior Medias-

tinum; another, passing from the posterior face of the pericardium to the dorsal vertebræ, is the Posterior Mediastinum; and a third, which is within the circuit of the first ribs, is the Superior Mediastinum. This division, though evidently arbitrary, is indispensable to a correct account of the relative situation of very important organs placed between the two pleuræ.

1. The Anterior Mediastinum is less important than the other two; the portions of the two pleuræ of which it consists are almost in contact, and contain between them some loose cellular substance by which they adhere together, and by cutting through which, after a longitudinal section of the sternum, they are easily separated from one another. The upper part of this septum contains the remains of the thymus gland; its lower part leaves the middle line of the sternum, and inclines to the left side; and when the sternum is narrow below, it is attached to the anterior ends of the cartilages of the lower true ribs of that side.

2. The Posterior Mediastinum, where it leaves the vertebræ to reach the pericardium, passes off from a line nearer the heads of the ribs on the left side than on the right. The descending portion of the thoracic aorta is contained within this septum, on the left side of the dorsal vertebræ. The œsophagus is in its middle in front of the vertebræ above, but, in descending, it crosses in front of the aorta, and inclines to the left side of the dorsal vertebræ to reach the foramen œsophageum of the diaphragm. The vena azygos occupies the right side of this mediastinum, and, after ascending, forms an arch over the root of the right lung, and terminates by joining the descending cava. The thoracic duct, after entering the thorax between the crura of the diaphragm, ascends in front of the dorsal vertebræ between the aorta and the vena azygos, and behind the œsophagus, till it reaches the third dorsal vertebra; it then inclines to the left side, and, mounting into the root of the neck near the vertebræ, it finally makes an arch, which, by advancing forwards, terminates in the angle formed by the junction of the left internal jugular and left subclavian vein. The par vagum nerve, of each side, is also in the posterior mediastinum.

3. The Superior Mediastinum is bounded in front by the upper part of the sternum, behind by the upper dorsal vertebræ, and laterally by the first ribs. The cavity is conoidal, with the base upward, but is too peculiar to admit of a rigid comparison with anything else. The pleuræ are reflected downwards from the internal edge of the first ribs, not abruptly, but in a rounded bulging manner, receiving there, as mentioned, the tip or apex of the lungs, and lining the inferior surface of the scalenus anticus muscle. In order to understand well the position of the pleuræ, it must be borne in mind that the upper rib is placed very obliquely downwards and forwards, at an angle of about forty-five degrees with the spine; consequently, the pleura, on being reflected from its whole internal edge, is much higher at the head of the rib than it is at the anterior extremity of the same. This cavity

is continuous, of course, with that of the anterior mediastinum in front, and also with that of the posterior mediastinum behind.

The remains of the thymus gland are where this cavity joins the anterior mediastinum: a part of the gland is, indeed, in each of these cavities, just below the transverse vein. In contact with the right pleura is the descending Vena Cava. The common trunk of the Left Subclavian and Internal Jugular, called the Transverse Vein, or Vena Innominata, after crossing in an oblique descent behind the upper portion of the sternum, joins the descending cava an inch above the place where the latter penetrates into the pericardium. Behind the transverse vein are the top of the arch of the aorta, the arteria innominata, the left carotid, and the left subclavian. The trachea, with the œsophagus behind it, descends along the middle line in front of the spinal column. The arteria innominata crosses the front of the trachea from left to right in ascending; it is in contact with the transverse vein, and more superficial than either of the other arteries. The phrenic nerve, passing at the internal edge of the scalenus anticus, between the subclavian artery and vein, descends vertically in contact with the pleura. The par vagum passes along the side of the trachea, and afterwards behind the corresponding bronchus, having got into the superior mediastinum between the subclavian vein and artery: its inferior laryngeal branch encircles the subclavian artery on the right side, and the arch of the aorta on the left.

The internal surface of the pleura is smooth and polished, and is moistened and kept lubricated by an unctuous serum, the natural quantity of which is merely sufficient to allow the parts to slide freely upon each other. In dropsy of the chest, it is augmented frequently to such an amount as to cause the collapse of the lung by pressing upon it.

In the cellular tissue, between the pleura and pericardium, as well as on the diaphragm, adipose matter, in considerable abundance, is found in corpulent persons advanced in age.

The blood-vessels of the pleura costalis are derived from those which supply the parietes of the thorax, as the intercostals and phrenics. They ramify in the subjacent cellular substance, and end by exhalant orifices on the internal face of the pleura, from which a minute injection is poured out very copiously.

BOOK VIII.

THE CIRCULATORY SYSTEM.

PART I.

HISTOLOGY OF THE CIRCULATORY SYSTEM.

CHAPTER I.

GENERAL CONSIDERATIONS.

The Circulatory, or the Vascular System, consists in a congeries of tubes, or cylindrical canals, which convey the blood to and from every part of the human body; and, therefore, enter into the texture or composition of almost every portion of it. In all animals there seems to be a necessity for the alternate reception and discharge of alimentary materials; in the higher orders, this is effected through the agency of the vascular system; but in the most simple animals this system does not exist, and their whole fabric being soft and permeable, nutritious matter is introduced by a direct absorption, or a species of capillary attraction, after the manner of a sponge, or any other porous body, and is discharged by a process equally simple.[1] It is probable that there are some parts of the human body whose mode of nutrition is analogous to the latter; as, for example, the articular cartilages, the hair, nails, and so on; for many observations tend to prove that all these organs have an interstitial circulation.

In many animals, the blood is propelled from a central point, called the heart, to all parts of the body, and then returns again to the heart. The first movement is executed through canals called arteries, and the second through veins. It is the most simple scheme by which a circulation can be carried on through a sanguiferous system, and requires a heart with only two cavities; one for propelling blood into the arteries, or departing tubes, and another as a reservoir for receiving the blood of the returning tubes, or the veins. The two cavities must be near each other, and have a valvular opening between them, which

[1] Hunter on the Blood. Béclard, Anat. Gén.

will permit the blood to pass from the venous into the arterial reservoir; but not from the arterial into the venous. A circulation of this simple cast is found in fishes, and in animals generally whose respiration is effected on the surface of the body; but in man, and in other warm-blooded animals, where respiration is carried on interiorly by means of the lungs, their circulatory apparatus is double; one part being for the lungs, and the other part for the body generally.

In man, the heart consists of four cavities; two auricles, or reservoirs of blood from the veins, and two ventricles, into which the venous blood is transmitted, and which, in their functions, may be compared to the forcing-pump of a fire-engine. The circulation is effected in the following manner. The blood contained in the right auricle of the heart flows into the right ventricle, and from the latter it is forced through the pulmonary artery into the lungs. It returns from the lungs through the four pulmonary veins, and is received into the left auricle of the heart; from the latter it flows into the left ventricle, and is propelled from it into the aorta. The aorta then distributes it through the whole body by an infinitude of small branches; from the latter it is collected, by corresponding veins, into two trunks, the Ascending and the Descending Vena Cava. The ascending vena cava brings the blood from the lower extremities and from the abdomen; the descending vena cava brings the blood from the head and neck, the upper extremities, and the parietes of the thorax. These two trunks finally discharge the blood into the cavity from which it started, to wit, the right auricle. The same round is then renewed, and continues to be repeated during the whole course of life. It is customary for anatomists to call the route of blood from the right ventricle, through the lungs, to the left auricle inclusively, the lesser, or the pulmonary circulation; and that which begins at the left ventricle, goes through the whole body, and ends in the right auricle, the greater circulation.

The blood contained in the veins of the greater circulation, in the right auricle and ventricle, and in the pulmonary artery, is of a dark brown or reddish color; while that contained in the pulmonary veins, in the left auricle and ventricle, and in the aorta and its ramifications, is, from being vivified by respiration, of a carmine or vermilion complexion. The celebrated Bichat has, upon this difference of color, founded his division of the whole circulating system into two parts; one containing black blood, "Système vasculaire à sang noire;" the other red blood, "Système vasculaire à sang rouge." This division, having general physiology for its object, affords a well-marked distinction, suited to such discussions.

The lymphatics also are a part of the circulatory system, but as they do not commonly convey red blood, the consideration of them will be introduced subsequently. "They take a very active part in the animal economy, whether natural or diseased, and seem, in many actions, to be the antagonists of the arteries, while the veins are much more passive, being principally employed in returning the blood to the heart."[1]

The largest vascular trunks are situated near the centre of the body

[1] Hunter, loc. cit.

and limbs, on the side upon which flexion is accomplished, while those near the surface are generally small. Most commonly there are one artery, one or two veins, and several lymphatics, all together.

The arterial system in its external configuration may be compared to a tree, the trunk of which is attached to the heart, and which by a continued succession of divisions and subdivisions reaches to every part of the body. There are no means of estimating rigidly the collective area of the branches in proportion to that of the trunk, but a little observation on the size of the primitive branches will satisfy one of their great excess; and as the rule is maintained throughout, there must finally be an immense disproportion. We have then reason to believe that, if all the branches were assembled into a single cavity, this cavity would be somewhat like a cone, the apex of which would be next to the heart. The same rule holds in regard to the venous system, it being observed, however, that the latter has two trunks connected with the heart instead of one. The general rule is, therefore, established throughout the vascular system, that the collective area of the branches is always greater than that of the trunk from which they proceed.[1] By the same rule the circulation in the branch must be

[1] I am indebted to a scientific friend, Mr. Erskine Hazard, for the following computation, by actual measurement, of the arteries, from which it appears that in many of them, at least, the area of the trunks is greater than that of the branches near them.

The Left Carotid at the Aorta is	.42
Its diameter at the branching is	.43
Increase of diameter	.01
Its square at the Aorta is	1764
Each Carotid branch measures .28, and the sum of their squares is	1568

The difference of the areas of the Carotid and its branches is 12½ per cent. in favor of the Carotid.

Diameter of Aorta near the Iliacs		.64
Its square		4096
Diameter of Left Iliac	.40	
Its square	1600	
Diameter of Right Iliac	.37	
Its square	1369	
Sum of their squares		2969
Aorta largest by nearly 38 per cent., or		1127
Square of Right Common Iliac, as above		1369
Ditto External Iliac	900	
Ditto Internal do	729	
		1629
Branches largest by nearly 19 per cent., or		260
Square of Left Iliac as above		1600
Ditto Internal Iliac	961	
Ditto External do	900	
		1861
Branches largest by above 16 per cent., or		261

more languid than in the parent trunks, as this circulation is retarded both by additional friction and by having to fill up a larger canal.[1] The course of rivers exemplifies this continually; while confined to narrow channels, they rush tumultuously through them, but when they begin to expand themselves into capacious basins, or to be divided into a multitude of smaller channels, the current becomes slower, and in some cases imperceptible, though the fact is clear that an equal volume of water is everywhere descending in the same period of time.

The moisture conferred upon all parts by the circulation of the blood bears a sufficient analogy to the effects of irrigation upon ground. The water may be conducted to the latter by a canal, and is finally divided into an infinitude of streamlets, which ramify everywhere, and from the porosity of their beds percolate laterally, so that the whole field, even to its most minute atom, is kept moistened. The streamlets, afterwards, successively assemble again into a single canal, which bears off their superabundant water. From the nature of the particles of

Great Sinus of Valsalva		13456
Innominata	2601	
Carotid	1444	
Subclavian	1024	
Aorta beyond	3600	
		8669
Sinus greater than all, by or 55 per cent.		4787

Comparison of the areas of the Iliac Arteries with that of the Aorta, half an inch above them, in decimals of an inch.

	Left Iliac.	*Aorta.*	*Right Iliac.*
Greatest diameters	.354	.556	.390
Least do	.290	.410	.290
Sum of diameters	.644	.966	.680
Mean diameters	.322	.483	.340
Their squares	103684	233289	115600
			103684
Sum of the squares of the Iliacs			219284
Square of the Aorta			233289
Aorta larger than the Iliacs or nearly $6\frac{4}{10}$ per cent.			14005

As the areas of circles are to each other as the squares of their diameters, it follows that the aorta will contain, in a given length, nearly $6\frac{4}{10}$ per cent. more than the two iliacs; and, consequently, the blood must flow that much *faster* through the iliacs than through the aorta, as the same blood has to be disposed of in both, in the same time. By this means the power of the heart is continued much farther through the system, as each artery is large enough to supply its branches with but little friction. The interior surfaces of the above iliacs are, together, 2.0806 inches, while that of the aorta is but 1.518 inches, or only three-fourths of the *rubbing* surface. Independently of this circumstance, it is found that there is a greater difference in the *quantities* of fluids passing through apertures of different sizes than there is in the *areas* of the respective apertures. This is accounted for by there being less friction between the *particles* of fluids than there is between these *particles* and a *solid;* and, in the larger apertures, a smaller proportion of the particles comes in contact with the solid.

[1] It is computed that the blood moves 5233 times slower in the capillaries than in the aorta.

blood, many of them are confined to their proper channels, and can never pass off by percolation into the tissue, through which the blood-vessels ramify. This may be proved by the fact of the red globules of blood having a diameter of from the $\frac{1}{3000}$th to the $\frac{1}{5000}$th part of an inch, a size inconsiderable as it is, yet too large to permit their flowing through elementary fibres or atoms; whereas serum, or the water of the blood, may, from the extreme fineness of the particles, be absorbed by any tissue whatever; a circumstance entirely unquestionable, both from daily observation, as, for example, in soaking a piece of dried meat or a bone; and from the reflection, that the air itself will hold a certain quantity of water in solution.

A question then arises whether the moisture of parts not supplied with red globules of blood, comes in the living body exclusively from infiltration or from a peculiar set of vessels called exhalants, often talked of, but as yet never seen? That the lateral porosities of blood-vessels are large enough to allow watery fluids to exude, is readily proved by injecting water into the blood-vessels of a limb, or, of any other part, when the latter invariably becomes œdematous. It is in this way even possible to inundate a living animal, as I have seen accomplished by M. Magendie, in Paris. This moisture requires a change, and by continued additions would become superabundant: as it has been thrown out of the common current of the circulation, and could not be removed in any other way, the lymphatic system has, therefore, been added for the purpose. In the lower orders of animals, who are destitute of the blood-vessels, the interstitial change of moisture goes on without lymphatics.

No part of the human body is exempt from moisture, but it is furnished by smaller streams, and is also less abundant in some textures than in others; for example, though blood-vessels susceptible of conveying red blood do ramify through tendons and ligaments, yet they are not numerous, apparently; not more so, indeed, than what is sufficient to keep up, by a deposit of serum, the flexibility of those parts. The vascularity of a part during life may be ascertained by a simple process after death, the most vascular always lose proportionately of their bulk by drying; for example, a muscle shrinks more than a tendon, a gland more than a muscle.

Besides the operation of the lymphatics, much of the superabundant moisture is carried off by insensible perspiration and evaporation from the surface of the body: the latter process, however, is much restrained by the peculiar character of the cuticle, without which it would become excessive, probably so much so as to exceed any supply of fluid through the stomach.

The red globules of the blood, besides their less obvious uses, unquestionably serve to inspissate the serous or watery part, by an intimate mixture with it, and thereby put a certain restraint upon its extravasation. They also, from their size, serve to keep open the channels through which the blood circulates. So much associated is the existence of *red globules* with regular *blood-vessels*, that there are but few examples of animals having the former, without also having the latter;

whereas, in animals whose circulating fluid has not red globules, but is a mere serum, the entire destitution of regular blood-vessels is very common, and their circulation, if the name be deserved, consists simply in the transmission of moisture from one pore to another, as occurs in a rag or in a sponge, by mere capillary attraction. Such animals form a numerous class in the chain of organized beings, and have a gelatinous consistence.

A remarkable feature in the vascular system, both arteries and veins, is the disposition of trunks to run into one another; or to form an anastomosis, whereby, if the blood should be cut off by one route, it may still be supplied through another. These communications are frequent in the head, in the neck, in the thorax, in the abdomen, and in the extremities; they exist, indeed, wherever the blood-vessels do, and become more numerous as the blood-vessels are smaller, or more removed from the centre of the circulation. It is unnecessary here to specify instances, as the more remarkable ones will be mentioned at a proper time. But some estimate may be made of their importance, and of the facility of communication established by them, when it is remembered that cases have occurred of obstructed aorta, without the circulation ceasing in the parts of the body beyond it: the same has occurred to the venæ cavæ, and to the thoracic duct also.[1]

The extreme vascular ramifications are called Capillaries (*vasa capillaria*), and they form the connection between the arteries and veins; or, by being intermediate to the two, they are the ultimate terminations of the arteries, and the commencing roots of the veins. From the extreme tenuity of these vessels, it is impossible to indicate where the arteries terminate and the veins begin; yet their continuity with the capillary system has been repeatedly demonstrated, by throwing injections from the one into the other system; and by microscopical observations made on the transparent parts of living animals, as the mesentery and the web foot of frogs, and the tail of fishes. These facts are sufficiently substantiated by the observations of Malpighi, Leeuwenhoeck, Prochaska, and a crowd of others; yet there are anatomists who hold a contrary doctrine, and admit the parenchyma of the ancients (an indefinable something, conceived, however, to be spongy) as a point of termination for the arteries, and of commencement for the veins.

Though the capillaries are all too fine to be seen distinctly without the microscope, yet they are found to have several gradations of size. The largest of them are those which only escape the naked eye, experiencing successive divisions, whereby their diameters are reduced from admitting a file of several globules of blood, to the caliber of one globule only.[2] The capillaries have also frequent anastomoses with one another. Sometimes the artery is simply doubled on itself, and immediately becomes a vein: on other occasions, several capillary arteries run into the same vein.

The anastomoses finally end in a continuous intertexture of vessels, which is common to both the arteries and veins. Although the limits

[1] Béclard, Anat. Gén.

[2] Béclard, loc cit.

of the two sets of vessels cannot be precisely defined, so as to learn where one set ends, and the other set begins, yet the capillary system may be known by the greater uniformity of size in its vessels.

Their diameter varies from the $\frac{1}{1000}$th to the $\frac{1}{5000}$th of an inch, but the medium measurement is from the $\frac{1}{1850}$th to the $\frac{1}{3700}$th of an inch. The following table will show the result of measurements upon injected preparations:—

Brain . . .	$\frac{1}{4700}$	according to	Weber.
Kidney . .	$\frac{1}{1529}$ to $\frac{1}{2500}$	"	Müller.
Ciliary processes .	$\frac{1}{1754}$	"	"
Mucous Membrane of Large Intestine	$\frac{1}{1851}$ to $\frac{1}{2794}$	"	Weber.
Lymphatic Gland	$\frac{1}{1851}$ to $\frac{1}{2794}$	"	"
Skin . . .	$\frac{1}{1149}$	"	"
Inflamed Membrane	$\frac{1}{1928}$ to $\frac{1}{3846}$	"	"

As a general rule, their diameter may be stated at from one to five globules of red blood.[1]

By the above, it will be seen that their diameter is sufficiently large for transmitting the blood-disks. But the capillaries are decidedly smaller than any other of the tubular structures of the body having a vascular supply.

The capillaries pass between the primitive fibrils of muscles and nerves, and form an intertexture around them; but, as in other tissues of a very fine kind, they do not penetrate them, because those tissues have in their elementary filaments a finer diameter than either the capillaries, or even the red globules of the blood.

When the capillary communications are unduly enlarged, they constitute what has been called by Mr. John Bell the aneurism from anastomosis, a frequent mark in young children, and which, when it has developed itself fully, has a spongy structure resembling the erectile tissues, as the corpus cavernosum penis, &c. As there is a double circulation, so there is a double capillary system, one for the lungs and the other for the body generally: to these may be added a third, which exists in the liver, between the hepatic extremities of the vena portarum and the hepatic veins.

The texture of the capillary vessels is too fine to admit of much scrutiny, but they appear as simple cylindrical excavations in the substance of the part to which they belong. This appearance has led many respectable anatomists to the conclusion that they were absolutely destitute of walls. Gruithuisen saw the blood flowing in free spaces between the acini of the liver in the frog. Müller saw the same in the liver of the larva of the triton. Wedmeyer came to the same conclusion, in witnessing the broad currents of blood, with the small islets between them, in the lungs of the salamander. There are many other authorities on the same side. On the contrary, Leeuwenhoeck, Haller, Spallanzani, Prochaska, Bichat, Berres, and Rudolphi admit the existence of such membranous walls. Without the latter, we can scarcely account for the anatomical injection of fluids, passing from the arteries into the

[1] Béclard, loc. cit.

veins, without extravasation; and for currents of blood, crossing above and below each other, without mixing. Windischman has injected, in the cochlea of birds, the blood-vessels of a very soft plicated membrane, which, upon being dissolved in water, left a beautiful vascular net-work with the meshes empty. Schwann has observed, in the capillaries of the mesentery of the frog, an arrangement of circular fibres, and Müller, after injecting the vessels of the kidney of a squirrel and macerating the glandular structure off, found the capillaries on the tubuli uriniferi apparently independent vessels.[1]

It is not improbable that they may be uninterrupted continuations of the internal coat of the arteries into that of the veins. They have striking powers of extension and of contraction, and are easily irritated. An emotion of the mind, as a sentiment of shame or a feeling of resentment, quickly causes those of the face to become turgid with blood. Local stimuli cause congestions in them. Cold, the application of a weak acid, or fear, causes them to contract; though, under the influence of the heart, they are less so than larger vessels. Their innumerable channels cause a comparatively languid circulation of the blood in them, for reasons mentioned; and, by furnishing it with more places of contact with their parietes, put it more under nervous influence than it is elsewhere.

These vessels are not equally abundant in all the textures of the body. Their quantity may be ascertained by the redness which a part acquires by inflammation, as well as by fine injections: the latter proof is preferable, as, in the former, it is difficult to distinguish them from the extravasations which also occur at the same time. The celebrated injections of Ruysch, from their unusual minuteness, induced him to think that every solid portion of the body was vascular, yet he admitted that some portions were more vascular than others, thereby conceding to his antagonists that some points, at least, were not formed by blood-vessels. In the microscopical examinations of living animals, (for example, the frog,) it is seen that in their feet the smallest capillaries are separated by distinct intervals, while in the mucous membrane of the lungs the finest needle cannot have its point inserted without opening several of them.[2] The younger an animal is, the more vascular are its parts: but, on the contrary, as it advances in age, the proportion of parts not susceptible of injection increases, while the capillaries diminish in number. In cold-blooded animals, it is very evident that some of these capillaries, or arterio-venous communications, are large enough to admit a file of several red globules abreast, while others allow a single file only.

The arrangement of the capillary net-work is for the most part uniform, the principal variation being in the size of the meshes, and in their being elongated or not. In muscles and nerves, the elongation is in the direction of the primitive fibrils, and the same may be said of every tissue consisting of parallel filaments. In the intestines, the capillary vessels, being first arborescent, anastomose very freely; in the placenta they resemble a tuft; in the spleen a sprinkling brush; in the tongue a hair pencil; in the liver a star; in the testicle and cho-

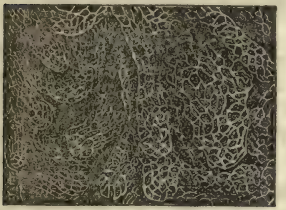
[1] Müller, Phys. p. 230.

[2] Béclard, Anat. Gén.

roid plexus of the brain a lock of hair; in the Schneiderian membrane a fine trellis-work. In the cortical portion of the kidney, there are glomeruli or small bulbs of vessels in the midst of the common anastomosis and fine vascular net-work; having wound itself up in that way, the artery then emerges on the other side, and is lost in the adjacent capillary tissue. This is said, according to Tiedemann, to be particularly distinct in the triton and salamander. At the extremity of the villus of the human placenta, a minute artery is directly continuous with a minute returning vein.

In the medullary portion of the kidneys, in company with the ducts of Bellini, the arteries and veins run parallel with these ducts, anastomose across them, forming elongated meshes, and finally appearing on the papilla renculi, terminate in a fine net-work, surrounding the orifices of the uriniferous ducts. This vascular arrangement is frequently mistaken for the tubuli uriniferi themselves.

Fig. 217.



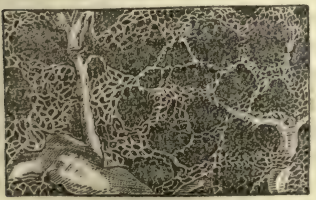
Distribution of Capillaries in the Villi of an Intestine.

Fig. 218.

Distribution of Capillaries around the Follicles of a Mucous Membrane.

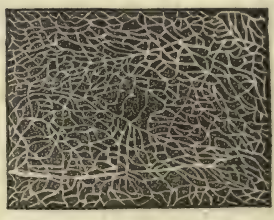
The most attenuated capillary net-work exists in the lungs, and in the choroid membrane of the eye. The interspaces are somewhat larger in the iris and ciliary body. The mucous membrane of the intestines, especially of the veins, has its capillary net-work so fine as to form almost the entire structure apparently, when it is successfully injected. Bones, ossific cartilages, tendons, ligaments, and the fibrous structures generally, are furnished with the fewest of them, and have the largest meshes.

Fig. 219.



Distribution of Capillaries around the Follicles of the Parotid Gland.

Fig. 220.



Capillary Net-work of the Nervous Centres.

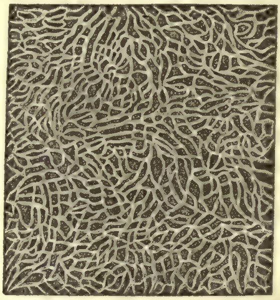
The nutrition of the body depends upon an alteration of exhalation and of absorption: but it is still undetermined whether there be any

vessels whatever whose especial office is that of exhalation, and which produce the several secretions and exhalations. If there be such, they are generally designated by the term exhalants, and their diameters are too small to transmit the red globules of blood; their function is, consequently, to give passage to the serous particles only.

Fig. 221.

Capillary Net-work in the Mucous Membrane of the Palpebral Conjunctiva.

Fig. 222.



Capillary Net-work in the Choroid Coat of the Eye.

This subject has been much agitated by anatomists, and marshals the best authorities on both sides. Among the distinguished advocates in the affirmative, are Boerhaave, Haller, and Bichat; and opposed to them are Prochaska, Mascagni, and Richerand. The leading facts of the former are: the microscopical observations of Leeuwenhoeck, who speaks of vessels admitting only serous globules; the phenomena of inflammation, which render red, parts naturally white and transparent; the difficulty of conceiving how the nourishment of certain parts can be maintained, whose capillary system of red blood is so limited, in proportion to points not susceptible of it. The opinion of Mascagni and others, to the contrary, is: that those exhalants, if they existed, should be seen readily, inasmuch as they are within the range of a microscope whose powers enable one to examine a body much smaller than a red globule of blood; that injections should penetrate them, instead of being limited to vessels whose existence is sufficiently confirmed by examination in the living state; that if during inflammation they do seem to be injected with red blood, the appearance is delusive, and depends upon the existing capillaries being dilated so as to receive more red blood than usual, upon the formation of new vessels, and upon sanguineous infiltration; and as to membranes naturally white, as the conjunctiva, the color depends upon the capillaries, while in a healthy state, being so small that they do not admit the red globules in a file sufficiently numerous to be perceived by the eye; the globules being, probably, then conducted in a series of one only, or in a single file, like a string of beads. It is, therefore, much more reasonable not to admit the existence of vessels which it is very doubtful whether any one has seen, unless we claim as such, the vessels which, under ordinary circumstances, do not convey red blood, at least in a visi-

ble manner; but are limited to the carrying of the liquor sanguinis, or, in other words, pure serous vessels, the existence of which is affirmed by Müller.

When a watery injection is pushed into a blood-vessel, it in a little time shows itself as a fine dew upon the surface of the serous and mucous membranes, in the cellular membrane, and elsewhere. According to many anatomists, it has gone through the system of exhalants, and, indeed, presents itself to sight in very much the same way that exhalation occurs in the living state. From the view which has just been taken, it becomes more probable that this perspiration is executed through the interstices or pores of the vessels. In the dead state it is merely a mechanical result, a simple straining of the fluid; whereas, in the living body it is a vital function, continually modified by the peculiar vital powers of the organ or membrane where it occurs; and, therefore, presents itself under the form of the different secretions. The question of the exhalants being a distinct set of vessels does not, however, appear to be one of much consequence; because, if they do exist, they must be very short and very small; and the assumption of their existence does not throw any light upon the function of secretion. For the latter is still an incomprehensible vital process, and, as far as we have any idea about it, it is quite as easy to conceive of its being performed in the parietes of the capillaries or in epithelial cells, as in the mouths of a distinct set of vessels whose length is too short to admit of an estimate.

Besides the supposed existence of a general system of exhalant vessels, some anatomists have thought that there was a species of them acting particularly as nutritive vessels. According to Boerhaave, every part must, therefore, be vascular. Mascagni thought that the extreme arterial ramifications are not only furnished with exhaling, but also with nutritive porosities; and that there are everywhere orifices of absorbing vessels, to contain the nutritive molecules. The theories of Bichat and of Prochaska do not differ materially from the latter. Whatever may be the mode of existence, and the route of nutriment to the several parts of the body, the operations involved are entirely too subtle even for microscopic observation. We, therefore, can only understand, in a general way, that the blood-vessels deposit, and the lymphatics absorb by invisible avenues in the cellular substance, the molecules of composition and of decomposition in our organs.[1] It is to this power that the name of vital force has been given, and especially that of the force of formation (*nisus formativus*).

The arteries, though commonly said to be cylindrical canals, are not exactly so, but, as they recede from the heart, increase somewhat in diameter, even where they do not send off any branches. In this way the arteries of the umbilical cord are evidently larger as they get nearer the placenta; and the spermatic arteries of a bull as they get nearer to the testicle. Observations made on the carotid arteries of the camel, and of the swan, by Mr. Hunter,[2] tend to prove the same disposition in them. The vertebral arteries afford a striking example of the same. It is probable that the rule extends to all arteries through-

[1] Béclard, loc. cit.

[2] On the Blood and Inflammation.

out the system, but it cannot be ascertained with so much certainty, because of the close succession of branches which they send off.

Arteries have within themselves a power of increase connected with the exigencies of the part to which they go; thus, the uterine arteries increase much in their capacity during pregnancy, while the hypogastric, from which they are derived, augment inconsiderably, and the primitive iliacs not in an appreciable manner. In animals of the deer kind whose horns are deciduous, the same augmentation of arterial trunks occurs while the horn is growing. Tumors are supplied in the same way. But in all these cases, after the exigency is passed, the vessels diminish to their primitive size.

With the exception of the semilunar valves at the orifice of the pulmonary artery and of the aorta, there are no others in the whole arterial system. These valves permit the blood to pass in the direction of the circulation, but not backwards, as they are closed immediately upon the cessation of the contraction of the ventricles. The tricuspid valve of the heart, and the semilunars of the pulmonary artery, are naturally not so perfect in their closure as those on the other side of the heart, but permit a small quantity of blood to retrograde.[1] As life advances, the valves of the aorta are much disposed to ossification and derangements of different kinds, which render them much less perfect than those of the pulmonary artery.

CHAPTER II.

OF THE TEXTURE OF THE ARTERIES.

The arteries are composed of three coats: an external, a middle, and an internal.

The External Coat, also called Cellular, is, in fact, condensed areolar or cellular substance formed into a cylinder. Its fibres run in every direction, so as to be perfectly interwoven with one another. The exterior periphery of this coat is continued into the adjacent cellular substance, but its internal face is united more closely to the middle coat; not, however, so tightly as to prevent a slight sliding of the one upon the other, and to forbid their easy separation by a knife. Scarpa is not disposed to admit this as one of the coats of arteries, and says that it only serves as an exterior envelop, and retains them in their places. This coat manifests its fibrous character in not being disposed to secrete fat, and is more distinct in the large arterial trunks. It has considerable strength and elasticity, both circularly and longitudinally, and is remarkable for its whiteness. If an artery be surrounded by a tightly drawn ligature, the middle and the internal coats will be completely cut through by it, while the external coat remains entire. This

[1] Hunter, loc. cit.

coat, then, answers the purpose of a strong investing fascia,[1] in which respect it may be considered as a sheath to the proper arterial structure, though the term sheath is commonly applied to the cellular membrane on its outer side. Under the microscope, Henlé has detected in the larger arteries an internal face to this coat, of genuine elastic tissue, but it disappears on the smaller arteries.

The Middle Coat of the arteries is called the Muscular, the Proper, the Tendinous, and so on. It is of a light yellowish tinge, and decreases continually in thickness, with but a few exceptions, from the heart to the ends of the arteries; it is, however, proportionately thicker in the small arteries than in the large ones. Its fibres are circular, but do not individually perform the circuit of the vessel. They are parallel to each other, and adhere laterally by very slender ties. In the larger arteries, this coat may be divided into several laminæ, though the division is entirely artificial. There are no longitudinal fibres whatever in it; the consequence of which is that an artery, divested of its external coat, yields more readily in the direction of its length than of its circumference.

The middle coat has a firmness, whereby, even when an artery is emptied, the cylindrical shape is still retained. Its character seems to be the result of a mixture of elastic and of muscular properties derived from a state of tissue decidedly peculiar; but which some anatomists have been very desirous of ranging under the head of muscles, others under that of ligaments, and a third under both united. The celebrated John Hunter, whose observations were generally made with the most scrupulous attention to perfect exactitude, and were often repeated, so as to make one confirm another, and who has received that sanction of greatness in which one's posthumous reputation becomes more exalted than the living, bestowed much attention on this subject. He was induced to believe that this middle coat was formed by a muscular lamina internally, and an elastic one externally; which distinction might be rendered evident by cutting a contracted artery through *transversely*, when the muscular coat would be found projecting beyond the other. He acknowledges, however, that he never could discover the direction of the muscular fibres; though he supposed them to be oblique, because their degree of contraction was greater than a straight muscle could produce.

The elastic contraction of an artery is manifested both in the direction of its length and of its circumference; for, when put upon the stretch in either way, it has the ability of returning to its original dimensions after the distending force ceases. The muscular contraction, however, only occurs in the circumference, and not at all in the length: by it the caliber of arteries is reduced to a very small diameter, if an animal be slowly bled to death. If, in this contracted condition, an artery be slit open *longitudinally*, the elastic coat will, at the cut margin, project beyond the other, which Mr. Hunter considers as another way of ascertaining the existence of the

[1] Jones on Hemorrhage.

two tunics. But if this same artery be then stretched transversely, the muscular coat will project beyond the other, for the reason that, if a muscle, after death, be elongated by force, it has no power of returning from that state, but will remain precisely as it is: whereas, elasticity being a property of matter enjoyed quite as fully in the dead as in the living state, the elastic coat of the artery returns to the medium condition.

Mr. Hunter, with a view of satisfying himself on these several points, had a horse bled to death, so as to obtain the vessels at their minimum of contraction. A circular section of the aorta measured, at first, five inches and a half, and, on being stretched, it lengthened to ten inches and a half; being let alone, it contracted to six inches, at which it remained stationary; the difference between six inches and ten and a half was then the amount of its elastic power, while only half an inch of contraction was due to the muscular stratum, or, in other words, an eleventh of the whole.

A section of the iliac artery, measuring two inches in circumference, on being allowed to contract after stretching, measured two and one-third inches; it, therefore, gained one-sixth the amount of its muscular contraction. A section of the axillary artery gained one-eighth; of the carotid, two-thirds; of the radial artery, doubled its primitive extent. From all which the inference was drawn that the power of recovery in a vessel is greater in proportion as it is nearer the heart, but lessens as the distance increases, which shows the decrease of elastic, and the increase of muscular, power.

The elastic coat gives a middle state to an artery, or has a continued tendency to it; if, therefore, the artery be too much dilated, it contracts it, and, if it be too much contracted, it dilates it, all of which is really exemplified by a cylinder of gum elastic, which, whether compressed or dilated, has only one state of repose, to which it immediately returns on being left to itself. Mr. Hunter supposed that a certain degree of elasticity is continued to the very end of every artery, from this quality being better suited to sustain a permanent resistance than muscular power; as a pipe of lead, from its want of elasticity, finally becomes stretched and useless under the pressure of a column of water, whereas, one of iron, from being elastic, always reacts efficiently. It is this elasticity in the arteries which causes the blood, at a little distance from the heart, to flow through them in a continued jetting stream when they are opened, although it is supplied to the aorta by interrupted strokes. In this way, as the artery is more distant from the heart, the stream becomes proportionately regular.

"The muscular power of an artery renders a smaller force of the heart sufficient for the purposes of circulation; for the heart need only act with such force as to carry the blood through the larger arteries, and then the muscular power of the arteries takes it up, and, as it were, removes the load of blood while the heart is dilating. In confirmation of this remark, it is observable, in animals whose arteries are very muscular, that the heart is proportionably weaker, so that the muscular power of the vessels becomes a second part to the

heart, acting where the power of the heart begins to fail, and increasing in strength as that decreases in power."[1]

After many discussions on the above, the present state of microscopical anatomy may be considered as leading to the following conclusions: The fibres which make the middle coat of the arteries are identical with those of the ligamenta flava of the vertebral column and the analogous tissue, as the elastic ligamentous structure of the trachea, and the vocal and crico-thyroid ligaments of the larynx. This elastic tissue is everywhere distinguished by the great inequality in the size of its fibres, and by their anastomosing with each other. It is of a yellow color, and its elasticity is well, though not fully preserved in alcohol for an indefinite duration. This elasticity is an almost purely physical quality, both in the living and dead state; not absolutely so, but a near approach to it.

The fibres of this elastic tissue are prismatic, or four-sided, and have a diameter from $\frac{1}{6000}$th to $\frac{1}{4500}$th of an inch. In the coat of the arteries their course is more decidedly circular and parallel than in the ligaments. In both cases the heat of boiling water draws them up, but does not destroy their elasticity.

Among the traits which distinguish the middle coat of the arteries from muscular tissue, is its not contracting under the strongest electric and galvanic stimuli, like muscles commonly. Nysten repeatedly experimented with galvanism on the aorta of criminals just beheaded, but did not perceive the slightest contraction of its fibres. Similar experiments with the same results have been instituted by many others, and amongst them Müller.[2]

The Internal Coat of the arteries is designated by the terms Nervous and Arachnoid. It is continued from the ventricles of the heart, in the left one of which it is of greater thickness. It is the duplication of this membrane, with some fibres interposed, that composes the semilunar valves of the aorta and of the pulmonary artery. Its internal face is smooth, polished, and moistened with a kind of humidity which permits the blood to flow through with diminished friction. In the larger arterial trunks, some small longitudinal wrinkles are observable in it; and when an artery has been cut through, as in amputation, it is disposed to retract in small transverse wrinkles. It is, therefore, not very extensible, but has, according to the experiments of Sir Everard Home,[3] a considerable degree of solidity and strength.

The internal coat of arteries possesses, to a limited extent, the elastic and other qualities of the middle, but it is generally considered as belonging to the class of serous membranes. A very delicate layer of epithelial scales with oval nuclei, according to Henlé, occupies its internal face. This coat may be stripped with great facility from the aorta after steeping it for some time in alcohol. It is then found to be very thin and semi-transparent.

The chief thickness of the inner coat, according to Henlé, is made by a peculiar texture which he calls the fenestrated or perforated mem-

[1] Hunter, loc. cit. [2] Loc. cit. p. 217.
[3] Transactions for the Improvement of Medical and Surgical Knowledge, vol. i.

brane, from the great number of fine foramina in it. It is made by a fine transparent brittle fibre forming one or several layers, which, when separated in small shreds, curl up at their borders. Longitudinal striæ-like fibres, making a net-work, are found in it. This coat, or rather part of the inner coat, is probably a modification of the elastic yellow tissue.

Ossifications of this membrane are very frequent, after the age of sixty.

In addition to the tunics mentioned, cellular substance, vessels, and nerves enter into the structure of arteries.

The Cellular Substance is not abundant, and serves principally to unite the sides of the circular fibres to one another, and to join the internal to the middle coat.

The Vessels (*vasa arteriarum*) consist both in arteries and in veins, and come from the adjacent trunks, instead of from those on which they ramify. They may be made very distinct by a fine injection, or by laying them bare in the living body; when, in a little time after exposure, they begin evidently to carry red blood, and to grow turgid as in inflammation. The difference in the color of the blood distinguishes these arteries from the same kind of veins. Both arteries and veins may be traced very well into the middle coat, but not upon the internal, though the changes which occur in the latter, from disease and upon the application of ligatures, prove clearly that exhalation and absorption are continually going on there. For in inflamed arteries, an exhalation is seen upon their internal surface, and when a coagulum has been produced by ligature, it is finally absorbed.

The Nerves of the arteries, according to Wrisberg and Béclard, are numerous and considerable; form around them a plexus resembling that of the par vagum around the œsophagus, and follow them into the interior of our organs, with the exception of the brain, which has them only to its surface. They are proportionately more abundant in the aortic than in the pulmonary system; also upon the smaller than upon the larger arteries. The arteries of the head, of the neck, of the thorax, and of the abdomen, are supplied from the sympathetic nerve, while those of the extremities are supplied from the nerves of the spinal marrow.

The passing of the blood through the arteries is accompanied with a pulsating motion, which, for the most part, is exactly synchronous with the contraction of the left ventricle, and depends upon an increased quantity of blood thrown into them at the moment. The dilatation of the artery may be both seen and felt; "but were we to judge of the real increase of the artery by this, we should deceive ourselves; for when covered by integuments, the apparent effect is much greater than it really is in the artery itself; for in laying such an artery bare, the nearer we come to it, the less visible is its pulsation; and, when laid entirely bare, its motion is hardly either to be seen or felt. This apparent diastole of the artery is augmented in proportion to the solid matter covering it, whence tumors over large arteries have considerable motion given to them, and have often been supposed to be aneurismal. Arteries, in fact, during their diastole or dilatation, increase

much more in length than in width, and are thrown into a serpentine course: instead, therefore, of the term diastole, it should rather be called the elongated state."[1] Mr. Parry, of Bath,[2] has denied that the arteries dilate at all during their diastole: his opinion, however, is peculiar, though, in an experiment performed many years ago upon the carotid artery of a calf, its correctness appeared to me then to be fully proved.

There is scarcely a part of the body which presents more frequent varieties, in different individuals, than the arteries. These varieties are found in their place and manner of origin, in position, and in the number of their ramifications. They are comparatively rare in the trunks of the first order, more common in those of the second, and still more usual in those of the third and fourth. From these causes, discrepancies are continually found in the descriptions of the most approved authorities, and must last so long as writers repose upon a partial experience, instead of referring to what has been most generally observed.

CHAPTER III.

OF THE TEXTURE OF THE VEINS.

THE veins, from their duty of receiving the blood in all parts of the body from the extreme arteries, and returning it to the heart, by successively collecting it into the two venæ cavæ, may be more appropriately compared to the roots of a tree than to its branches. The variations in them, as well as their anastomoses, are more frequent than in the arteries.

They are more numerous than the arteries; for, in addition to two venous trunks attending each artery wherever the structure of the part is intended for locomotion, as in the extremities, and in some places upon the trunk of the body, there is a very abundant class of veins which are superficial or subcutaneous, and which, when filled properly with injecting matter, form a fine vascular net-work over the whole surface of the body.[3] These superficial veins, in some places, form trunks even larger than such as attend the arteries, and especially in the extremities. Besides the excess in number, the veins which attend the arteries (*venæ comites*) have a capaciousness which, in many cases, is double that of the latter. From these several circumstances, it results that the area of the venous system vastly exceeds that of the arterial.

In some cases the veins follow precisely the course of the arteries, one for one, as in the greater number of the viscera of the abdomen, where they have common points of entrance and departure. Sometimes two arteries discharge into one vein, as in the penis, the clitoris, and the umbilical cord; sometimes they pursue a course entirely different

[1] J. Hunter, loc. cit. [2] Experimental Inquiry on the Pulse, 1816-1819.

[3] Pauli Mascagni Anatom. Magna, Pisis, 1823.

from the arteries, as in the pia mater. For the most part they are less tortuous than the arteries.

The veins, when injected, assume a cylindrical shape, yet they differ materially from the arteries, in having much thinner coats, and in being so pliable that they collapse by their own weight. In the lower extremities, however, near the feet, and upon them, as the veins sustain the pressure of a long column of blood, they have additional thickness and strength, so as to approximate them more to the arterial structure. This provision will be found occurring in most places where they have much duty to perform.

" They are similar to the arteries in their structure, being composed of an elastic and muscular substance; the elasticity preserves them in some degree in a middle state, although not so perfectly as it does in the arteries. The muscular power adapts the veins to the various circumstances, which require the area to be within the middle state, and assists the blood in its motion towards the heart."[1]

The External Coat is thinner and not so strong as that of the arteries; in other respects, the resemblance is sufficiently close not to require any particular comment.

The Middle Coat, near the entrance of the larger veins into the heart, is distinctly muscular.[2] It is formed of soft extensible fibres, many of which, when the vein is held up to the light, appear longitudinal, while the most internal are circular; there are difficulties, however, in the separation of these fibres, which prevent their course from being accurately ascertained. Admitting this coat, with the exception of its muscular ingredient near the heart, to be of the same tissue (that is, the elastic ligamentous which prevails in the arteries), yet the filaments composing it are much more decidedly intermixed, according to my personal observations. Bichat and Meckel assert that the whole of them are longitudinal, and that there are none circular.

This coat in the human subject is much thicker in the system of the ascending than of the descending cava; it is also thicker in the superficial than in the deep-seated veins. In some subjects it is much better developed than in others. In certain parts of the body it is entirely deficient, as in the sinuses of the dura mater, and has its place supplied by this membrane; the same deficiency exists in the sinuses of the bones.

The Internal Coat is more delicate and extensible than the corresponding one of the arteries, is less liable to rupture, and less disposed to ossification, but is of the same nature. It is thrown into a considerable number of duplications, forming valves. Each valve is of a semicircular shape; is connected by its curved edge to the vein, while the straight edge is loose, and turned towards the heart. When the veins are injected backwards, these valves may be forced in the larger trunks, and give them a knotted appearance. The valves are commonly in pairs, but

[1] Hunter, loc. cit. [2] Béclard, loc. cit.

in certain veins, as the crural and the iliac, there are three of them together; very rarely do they amount to four. In some instances there is but a single one; this arrangement is more frequent at venous orifices, as the great coronary vein of the heart, the vena cava ascendens, the vena azygos. They are frequently found reticulated as if they had been lacerated, whence it has been supposed that the fibres which cross the sinuses of the dura mater are an elementary approach to the valves.

The valves are more abundant in the superficial than in the deep-seated veins, but they do not exist everywhere. There are none in the branches of the vena portarum, excepting the vasa brevia; none in the spine, in the umbilical vein, the cervical veins, the kidneys, womb, ascending and descending cava, or in the median vein. The valves are proportionately more abundant in the lower extremities.

From the tenuity of the parietes of the veins, the blood may be readily distinguished circulating through them. Their coats, like those of the arteries, are vascular, or have the vasa vasorum. The arteries come from the nearest small trunks, while the corresponding veins do not empty immediately, but secondarily, into the trunk, whose parietes they supply. They are well furnished with veins.

Their elasticity, both transversely and longitudinally, is well marked; but they are not so extensible in the latter direction as the arteries, while they are more so transversely. There can be no doubt of their spontaneous powers of contraction, for it is abundantly proved by their diminishing much in volume upon the application of cold; moreover, when a venous trunk, distended with blood, is intercepted by two ligatures and then punctured, it empties itself entirely and rapidly.

The circulation in the veins is produced, in a principal degree, by the contraction of the heart; their own contraction may also favor this motion, as well as lateral pressure from contiguous parts. As the movement of the blood in the smaller arteries is so uniform as to be almost without pulsation, so the latter disappears entirely in the veins. It is not clear that this circumstance depends exclusively on the friction experienced by the blood in passing through the capillaries, but is probably rather owing, as Mr. Hunter has suggested, to the veins receiving their blood from different arteries, some of whose channels are more circuitous than others, and consequently, their blood arrives at different times. The momentum of the heart, then, even if it did impinge upon those channels, would not be synchronous upon the venous trunk, but would be divided in such a way as to produce a tremor or confused motion. The larger veins, however, have near the heart a pulsation during the contraction of the auricles, arising from the arrest of their circulation at the moment. During inspiration, the vacuum created in the thorax hurries on the blood to the heart, but in expiration it is somewhat impeded.[1]

[1] This ancient observation has lately been renewed, with additional interest and details, by M. Barry of Paris. See a Report of MM. Cuvier and Dumeril, concerning the Influence of the Atmosphere on the Circulation of the Blood, in the "Philadelphia Journal of the Medical and Physical Sciences," for July, 1826. M. Barry has probably assigned too much importance to this influence, as it is certain that the circulation may go on very well where no vacuum is produced at intervals in the thorax; for example, in the fœtus, in incubation, and in fish.

It has sometimes happened, that a large vein near the heart being opened by accident or an operation, a strong inspiration has caused the introduction of air, which, being carried to the heart, has produced instant death. It occurred in Paris to the celebrated surgeon Dupuytren, and has occurred to others.

CHAPTER IV.

OF THE BLOOD.

The Blood is the fluid from which is derived the aliment for the growth and repair of all other parts of the body. It is renovated by the accession of new nutriment introduced into the system through the process of assimilation, and it has also a large increase from the decomposed materials of the several textures of the body. A copious excretion takes place from it through the different glands and emunctories. The precise manner of its formation is imperfectly understood; it would at least seem to require no very complex apparatus for its formation, as it is generated in the area vasculosa of the germinal membrane of an egg, before the organs exist in a distinct state.

The blood, in the human subject, and in many animals, is of a red color. It is about the consistence of thin size, has a peculiar smell, a nauseous and slightly saline taste, and is somewhat heavier than water; its specific gravity being about 105, and its temperature in the living body is from 96 to 98° of Fahrenheit.

The method devised by M. Valentin to determine the exact proportion and quantity of blood in an animal has the merit of greater exactitude than any other, and seems to have solved this question with an accuracy almost unexceptionable. The weight of the animal is first ascertained; a certain quantity of blood is then removed, and evaporated to dryness; the weight of the residuum is then ascertained. A known quantity of water distilled is, upon drawing the first blood, thrown in by the same orifice and allowed to mix with the general mass of blood. This done, a second quantity of blood equal to the first is withdrawn, evaporated to dryness also, and the weight of its solid residuum ascertained. The quantity of the residuum in the two parcels determines the entire amount of blood in the animal by the following method:—

Thus, let two ounces of blood first drawn yield twenty-four grains of solid matter; and upon the injection of one pint and a half of water let two other ounces of blood yield only twenty-one grains of solid matter. Then multiply the quantity of water injected by twenty-one and divide by three (the difference in the two parcels of solid residuum): the result will determine the whole quantity of blood in the animal after the extraction of the first two ounces. Thus twenty-four ounces multiplied by twenty-one and divided by three, gives one hundred and sixty-eight ounces. Tried by this method, a dog of fifty-three

pounds weight is ascertained to have ten and a half pounds of blood, and forty-two and a half pounds of other materials in his composition, or one part of blood, and four parts nearly of other constituents.

There are some circumstances which may affect the absolute accuracy of the experiment, but the conclusion is so nearly satisfactory that M. Valentin, in taking the dog as the standard for the human body, fixes the quantity of blood in a man at thirty-four and a half, and in a woman at twenty-six pounds: the proportion in the first being, blood, 1; other parts, 4.30: and for the female, blood, 1; and other parts, 4.93.

A remarkable fact was observed in an emaciated and diseased dog, that the relative quantity of blood to other parts was the same as in health.

If the blood be examined microscopically while circulating in an animal, or immediately upon being drawn, it is seen to consist of red particles or globules swimming in a transparent fluid. This transparent fluid is the Liquor Sanguinis or Plasma, which is formed of serum and fibrin, the latter being in a state of solution in the serum. This state of solution has been proved by Müller in filtering through a porous paper the blood of a frog recently drawn: from the size of the red particles they are in this process left behind, and the serum and fibrin passing through together, the fibrin forms a coagulum[1] to itself. The proportion of fibrin in the human subject to the entire mass of blood would seem to be very small, as in the experiments of Lecanu he found fibrin, when dried, to form from about one and a third to seven parts in one thousand.

In a spontaneous coagulation the fibrin attaches itself to the red globules, and is found with them, while the serum separates and is squeezed out.

So long as it continues to circulate, or while it is still flowing from an opened vessel, the blood has, to common inspection, the appearance of a homogeneous fluid; yet, after it has been drawn a few minutes, and permitted to remain at rest, it assumes a thick gelatinous condition, expressed by the term coagulation, and by which it ceases to be any longer fluid. The coagulation begins on the surface of the mass, and by a thin pellicle, which shows itself in three or four minutes; commonly at the end of twenty minutes, the coagulation is complete throughout, but this rule varies according to the state of the body at the moment; and the coagulation is more protracted when the quantity of blood is large, and has been drawn through a large orifice, than where it is small, and has been evacuated through a small orifice. This change has scarcely taken place, when a spontaneous separation follows, whereby it is resolved into the watery part, the Plasma or Liquor Sanguinis or Serum, and into a thick condensed mass, called Cruor or Crassamentum. The serum first shows itself on the surface of the coagulum, in small drops, which, quickly increasing in number and size, finally run together, and form a mass of fluid exceeding considerably that of the crassamentum. The separation into serum and crassamentum, though sufficiently evident after a few hours, yet requires

[1] Physiology, p. 124.

some days for its complete accomplishment; for the coagulum, still continuing to contract, expels more and more of the serum.

The peculiar complexion of the blood depends upon the red globules. They do not seem to be an indispensable constituent, as many animals are entirely deprived of them, and such as naturally are possessed of them may have their quantity very much reduced by repeated bleedings. The coloring matter is generally an ingredient of the crassamentum, so that the whole of the latter has a red appearance; yet there are some conditions of the body in which a spontaneous separation of it takes place, more or less completely. For example, in inflammatory diseases the blood does not coagulate so soon as in health; and the red globules, from being naturally heavier than the other constituents of the crassamentum, subside to its bottom and leave it of a white semi-transparent color. It is this white part upon which depends the whole property of coagulating, and which has been called coagulating lymph, or fibrin. We have, therefore, three constituents of blood manifested by its own spontaneous changes; the Serum, the Red Globules, and the Coagulating Lymph.

As in inflammation the red particles subside to the bottom before the coagulation of the fibrin begins, the fibrin is seen more largely on the surface of the clot, and by a strong contraction in coagulating draws the top of the clot into the form of a saucer. There is, however, always a little fibrin left throughout the clot, and holding the red particles together; with the exception of a few which may be found at the bottom of the vessel, perfectly untrammelled by it. It was ascertained by Sir C. Scudamore that inflammatory blood contained more fibrin than healthy blood.

Coagulation, contrary to popular opinion, is not assisted by cold, but rather retarded by it: heat assists it.[1] If the heat be raised to 120°, blood will coagulate five minutes sooner than if left at its natural standard, and even sooner than if its temperature be reduced to 50°. If blood be frozen quickly, before it has time to coagulate, on being thawed it returns to the fluid state, and will coagulate afterwards. The contact of air does not produce coagulation. The late Dr. Physick, in order to ascertain this point conclusively, took a glass tube, which had a stopcock at each end, and attached one of its ends to the vein of a dog. A current of blood was then conducted through the tube, and while it was flowing, the far stopcock was closed, and immediately afterwards the other; thus, a column of blood was obtained which had not touched the air. After permitting it to remain a proper time, the tube was broken asunder, and the blood found coagulated as usual. Rest is not indispensable to the process, for blood, if shaken in a vial, will still coagulate. The division of the blood into small masses expedites coagulation. Therefore when it flows slowly from the blood-vessels, falls from some height, or runs for a distance over the surface of a dish, it coagulates sooner than under opposite circumstances. The latter are then auxiliary to the blood manifesting the sizy coat (one of the concomitants of inflammation); because, if the coagulation be very rapid, it will prevent the constituents

[1] Hunter on the Blood. Hewson.

of the crassamentum from separating from one another, by entangling the red globules in the coagulating lymph.

After death, the blood is coagulated in the veins, though not so perfectly or generally as is supposed, for there are no subjects which do not bleed from their large veins, when the latter are opened.

The coagulation of the blood is sometimes delayed for many hours after death. I have, in examining the head of a patient who died of phthisis pulmonalis, found the blood which came from the jugular veins in a thin fluid state and of a bright vermilion color; and upon being spread out on a plane surface it coagulated like recent blood.

There are many modes of death which prevent entirely the coagulation of the blood in the vessels; for example, where life is destroyed by a paroxysm of excessive anger; by electricity; by lightning; by a blow upon the stomach; by certain fevers of a typhoid character. Many chemical articles prevent its coagulation on being mixed with it.

SECT. I.—OF THE SERUM OF THE BLOOD.

Serum, is common to the blood of all animals, and is considered, by Mr. Hunter, to be more abundant in such as have red globules. It is, generally, of a lighter specific gravity than the crassamentum. I have, however, often seen the latter floating in it, which shows the contrary in some instances. Though its separation commonly depends upon the coagulation of the latter, yet that process is not indispensably necessary, as was once witnessed, by Mr. Hunter, in a lady in whom the serum was disengaged from the crassamentum, while the latter was yet in a fluid state. The phenomena of dropsy, also, prove the same point.

Serum, though very fluid, is not so much so as water. It is of a light yellow or straw color, varying, somewhat, in different subjects. It contains a large quantity, about eight per cent., of albumen, or matter resembling the white of an egg. It also consists of water about ninety per cent., of soda uncombined, and of several of the salts of soda, the presence of which may be manifested in several ways. For example, when exposed to a heat of 140 degrees of Fahrenheit, it becomes opaque, and at 160 or 165 coagulates firmly. During this process, a great deal of air is disengaged from it. It is also coagulated by spirits of wine, by all the mineral acids, by corrosive sublimate, and by many other articles. They all prove the presence of albumen. Mr. Brande considers the albumen as an albuminate of soda, and that its fluidity depends on the excess of soda; when, therefore, the latter is removed or neutralized by an acid, the albumen coagulates. Under the action of the galvanic pile, like the influence of heat, the soda produces mucus by blending with a part of the albumen; and the remainder of the latter not being able to retain its fluidity after the abduction of the soda, coagulates.

This mucus or serosity is, probably, the part which Mr. Hunter speaks of as retaining its fluidity when other portions of the serum are coagulated by heat. It is observed in meat either roasted or boiled, and comes from it as a thin, limpid fluid, somewhat tinged with the red

globules. The older the animal is, the greater is its comparative quantity: in lamb, there is scarcely any of it; whereas, in mutton five or six years old, it is abundant; the same rule seems to hold in regard to the human subject. This serosity, or mucus, is coagulable by Goulard's extract.[1]

The serum is not always transparent, but sometimes wheyish and thin; when it settles, it often throws up a white scum like cream and called Seroline. This more frequently occurs in pregnant women, though it is not confined exclusively to either sex, or to any known condition of body. The specific gravity of the globules composing this seroline varies; for, though it generally floats on the surface of the serum, it does not always; it also sometimes swims, and, on other occasions, sinks in water. It has been erroneously considered as chyle not yet assimilated, or as absorbed fat or oil. It is, probably, this substance which presents itself under the form of microscopic globules in the coagulum of serum; and when serum has been kept for several days, is deposited in the form of globules at its bottom. These globules present a singular motion of ascent and descent in the serum, upon the application of heat to it by holding in the hand. They may be identical with the white globules of the blood.

The presence of soda uncombined in the serum is readily ascertained by an infusion of red cabbage (*brassica oleracea*), or the juice of the flag (*iris versicolor*), which are both made green by it. Sulphur combined with ammonia is also found in it. Owing to the presence of sulphur, serum has the effect of blackening silver when left in it, and also has its power of dissolving the oxides of mercury, iron, copper, and other metallic preparations.

The serum contains a portion of fatty matter allied to the same substance in other parts of the body, and which may be extracted with ether. It also contains animal principles, whose general designation is that of extractive matter, and some of the ingredients of which are lactic acid and osmazome. They are believed by Berzelius to be the effete parts derived from the continual decomposition of the body, and which are conveyed away through the excretions. There are some other salts besides those mentioned which are found in serum.[2]

The serum has a specific gravity in health of about 1030, and contains about 9½ per cent. of solid matter, including the albumen, the seroline and the mineral constituents.

SECT. II.—OF THE FIBRINE OR COAGULATING LYMPH OF THE BLOOD.

Coagulating lymph, or fibrine, when circumstances are suitable for collecting it free from the red globules, offers the appearance of a semi-transparent body of a very light drab color; it is elastic and strong, and when subjected to the microscope, has the appearance of muscular fibres, by being composed of colorless globules. Like muscle, it also, when macerated in water, resolves itself into those globules before it putrefies.

[1] Hunter, loc. cit.

[2] See Henlé, Anat. Gén. t. i. p. 483.

If the blood, while flowing from an animal, be collected, and, at the same moment, stirred around and around with a rough stick, the fibrine will gather upon the latter in a fibrous form, so as to resemble a mass of entangled and knotted packthread. The fibrine may be afterwards washed almost white, and, at any rate, so as to clear it entirely from the red globules.

The fibrine, when dried, loses greatly in its bulk and weight by the evaporation of the serum from it, so that the proportion which it seems to bear to the whole mass of blood is much less considerable than one would suppose, from seeing it in the simple coagulated state.

The coagulating lymph of the blood being common, probably, to all animals, while the red particles are not, we must suppose it from this alone to be the most essential part; and, as we find it capable of undergoing, in certain circumstances, spontaneous changes, which are necessary to the growth, continuance, and preservation of the animal, while to the other parts we cannot assign any such uses, we have still more reason to suppose it the most essential part of the blood in every animal.[1]

SECT. III.—WHITE CORPUSCLES OF THE BLOOD.

In examining a drop of blood with a deep object glass, there is apparent in the field of vision a few white globules, the average diameter of which is about $\frac{1}{2800}$th of an inch. They are either smooth or granulated on the surface, semi-transparent and spherical, or nearly so. They differ from the blood-disks, or red globules, in being nearly the same in all animals; they are more obscure in the human subject and mammalia, but are very distinct in reptiles, birds, and fishes. They were first seen by Spallanzani in the Salamander, and then noticed in the blood of Mammalia, by M. Mandl, a few years ago; they are considered by the latter as produced by a coagulation of fibrin, and as identical with the globules of pus and mucus. By Mr. Gulliver[2] they are called nucleated cells or organic germs of fibrin: he is, however, doubtful of their perfect identity with the particles quoted by Mr. Mandl. Some of them, but not all, contain numerous granules which are in a state of quick molecular action.[3] Such cells vary in the fineness of their granules, and are converted into nucleated red corpuscles.

Besides the above, Mr. Gulliver has seen a white matter existing in abundance in the form of spherules, of from $\frac{1}{4000}$th to $\frac{1}{1777}$th of an inch. The animals in whom it was witnessed had died chiefly of tubercular phthisis, and he, therefore, is inclined to think this a pathological appearance.

Besides milky serum, which is sometimes found in the blood after a repast, corpuscles of a peculiar kind have been noticed in the splenic and supra-renal veins, which are supposed to come from the spleen and from the capsulæ renales.

[1] Hunter, loc. cit.

[2] Appendix to Gerber's Gen. Anat. p. 14.

[3] T. Wharton Jones on the Blood-Corpuscles, &c. Philos. Transactions, London, 1846; a paper of much research on this subject in the different animal series.

SECT. IV.—OF THE RED CORPUSCLES OR GLOBULES OF THE BLOOD.

The impression at the present day in regard to the red globules, or *Blood-disks*, as they are also called, is that they are flattened bodies of a circular shape and having a thickness from a fourth to a half of their breadth. To see them of this figure, they should be examined in fresh serum, a weak solution of common salt, or in thin syrup; if water alone be used, they contract into a spheroidal shape. In birds, reptiles, and fishes they are elliptical.

Fig. 223.

Fig. 224.

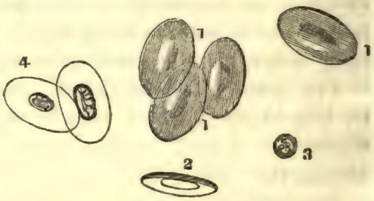


Fig. 223. Red Corpuscles of Human Blood, magnified about 500 diameters.—(1.) Single corpuscles. 1, 1. Their flattened face. 2. A corpuscle seen edgewise. (2.) Aggregation of corpuscles in a columnar form.

Fig. 224. Red Corpuscles of Frog's Blood, magnified about 500 diameters.—1, 1. Their flattened face. 2. A corpuscle turned edgewise. 3. A lymph corpuscle. 4. Red corpuscles altered by dilute acetic acid.

In the lower orders of animals the disk appears to have a central nucleus, which projects in a rounded form above the general surface of the disk. In the Siren, according to Professor Owen, the disk consists of from twenty to thirty spherical granules. But very great doubt exists in regard to the nucleus in man and the mammalia generally. Authority of the highest kind may be quoted for either opinion. Müller[1] says he has seen it; Carpenter is inclined to admit it; Gulliver[2] denies, and Wagner who once admitted it, now holds it as uncertain. Henlé[3] says that drying renders the nuclei of the corpuscles of the blood very obvious, and that, in calcining them, the wrecks of the nucleus and feeble traces of the envelop are discernible. This is the result of his observations on the lower orders of vertebrata, but in the human subject and mammalia, he evidently disinclines to the opinion of nuclei existing in the blood-disks. He says, in one place, that the pretended nucleus is only the depressed centre of the disk, and in another place he says that, in all his experiments, it has scarcely ever occurred to him to see any trace of nucleus. Numerous opinions for and against may thus be cited, and while the question is agitated by the best observers, others may very properly await their decision.

Under common observation the light transmitted through the centre of the blood-disks is more intense than elsewhere, which gives to them the appearance of being perforated or annular.

[1] Page 115.
[2] Appendix to Gerber, p. 15.
[3] Encyclop. Anat. vol. vi. p. 466, Paris, 1843.

By many, each blood-disk is considered, notwithstanding the difficulties of determining such minute points of structure in the human body, to consist in a capsule, a contained matter, and a nucleus in its centre. The advocates of this opinion also view it as a determined fact, that the blood-disks conform in their general character with the isolated cells, which constitute the whole of the simplest plants, each having an independent life of its own.

The improvements of the compound microscope have enabled us to determine, with accuracy, the diameter of the blood-disks or red globules. It appears now that there is no absolute or uniform size to them in the same mass of blood, but that they vary much in this respect, some being about $\frac{1}{5000}$th of an inch, and others about the $\frac{1}{3000}$th. Other animals than man present them of a larger or smaller size; thus, in the fish called Squalus Squatina, they are about the $\frac{1}{1000}$th of an inch, whereas in the cat they measure about $\frac{1}{7000}$th.

The different magnitudes in man are supposed to be accounted for by admitting them as cells in various stages of growth and evolution. Their size has no relation to the magnitude of the animal, for in the Mouse they have three times the diameter of those of the Musk deer.

The proportion of blood-disks varies very much in different persons: the average is about 140 in one thousand parts of blood in the male, but it may go to 186 or descend to 110 without ill health. In the female the average is about 112 in the thousand, but it may fall to 71 or rise to 167 in common health. In chlorosis it has been found as low as 27, and not unfrequently is at from 40 to 50 parts in the thousand.[1]

The blood-corpuscles, or blood-disks are larger in the embryo than in the adult. Mr. Prevost has seen that they were in the fœtal goat twice the size of such as belonged to the maternal. Mr. Barry asserts, that the germinal state of every tissue is that of corpuscles, having the same appearance with the blood-corpuscles; and Mr. Gulliver, that they are much more abundant in inflammatory diseases than in health.

It has been already observed that the red globules are the heaviest part of the mass of blood, and are, therefore, always disposed to subside to the bottom of the crassamentum, though from the quick coagulation of the latter, they can seldom do it fully before they become entangled in it, and thereby fixed to a certain place. They do not invariably retain their form, but are readily dissolved in water. They are, of course, insoluble in serum. Urine does not dissolve them; neither does a solution of muriate of soda, of sal ammoniac, epsom salts, nitre, diluted sulphuric or muriatic acid: the latter, however, deprives them of color.

The solution of red globules in water is manifested by the mixture becoming of a fine transparent red, and the process takes place almost immediately. On the contrary, when the globules refuse to be dissolved, a muddy mixture is formed. When they are dried in serum, and afterwards soaked again in it, they do not resume the regular form.

They have more substance than the coagulating lymph, for they do not lose so much of their bulk by drying.

The analysis of the blood-corpuscles presents two proximate principles,

[1] Carpenter's Elem. of Physiol. p. 309.

hæmatin or the colored principle, and globulin or the cell-wall. The first, according to Berzelius, amounts to about $\frac{5}{100}$th of the mass when the globules are dried, and when burned, it yields a quantity of peroxide of iron. The globulin makes about $\frac{95}{100}$th of the corpuscle.

The coloring ingredient of the red globule is commonly considered to be the Peroxide of Iron. In some recent experiments of Mr. Scherer, this belief has been assailed, if not invalidated, by his observing, that though the iron be removed, yet alcohol can be made intensely red by boiling in it the globules left after such extraction.

"It is difficult to determine by what means the iron, or the sulphur, or the elementary principles of the calcareous earths, obtain an existence in the blood. If these materials were equally diffused throughout the surface of the earth, we might easily conceive that they were introduced through the medium of food. But, as this is not the case; as some regions, like New South Wales, at least, on this side the Blue Mountains, contain no limestone whatever, and others, no iron or sulphur; while all these are capable of being obtained apparently as freely from the blood of the inhabitants of such regions, as from that of those who live in quarters where such materials enter largely into the natural products of the soil; it is, perhaps, most reasonable to conclude that they are generated in the laboratory of the animal system itself, by the all-controlling influence of the living principle."[1]

The red globules, according to the opinion of Mr. Hunter, from not being pushed into the extreme arteries, where the coagulating lymph reaches, and from not being found in all animals, do not contribute to the growth and to the repair of the system. But they seem to be connected with strength, in such animals as have them, as the strength acquired by exercise increases their proportion and occasions them to be carried abundantly into parts which previously, from a debilitated state, received them but partially, if at all. This fact is well known to graziers, who keep their quantity in certain animals, as veal, reduced by quietude and frequent bleeding.

Their source is not understood, though many conjectures on the subject have been hazarded.

Leeuwenhoeck asserted that they had the power of self-reproduction, and this statement has received additional confirmation by the observations of Mr. Barry.[2] According to him, the propagation takes place by the parent globule splitting into about six others, the development starting from its nucleus. As there is a continual decomposition going on, each disk or cell has a definite period of existence, and while some are dying others are coming into existence. Many physiologists suppose that they are a perfect state of the white corpuscles, which themselves come from the lymph and chyle.

Mr. Hunter's opinion was that they do not appear to be formed in those parts of the blood already produced, but rather to rise up in the surrounding parts: as, in the incubated egg, they exist in the form of a zone, composed of dots, previously to the formation of vessels.

The above sentiments of a very celebrated man, it may be well

[1] Good, Stud. of Med.

[2] Phil. Trans. 1840, and 1841.

enough to preserve, though they seem to be in contradiction with present views, except the appearance at first in the incubated egg.

The analysis of Mr. Lecanu, of all the elements, organic and inorganic, entering into the composition of the blood, is regarded as having a high claim to confidence. The blood was obtained in two parcels, each from a stout healthy man:—

Water	780.145	785.590
Fibrin	2.100	3.565
Albumen	65.090	69.415
Coloring matter (globules)	133.000	119.626
Fatty crystallizable matter	2.430	4.300
Oily matter	1.310	2.270
Extractive matter, soluble in water and alcohol	1.790	1.920
Albumen, combined with soda	1.265	2.010
Chloride of sodium; " potassium; Carbonates, Phosphates, Sulphates of potash and soda	8.370	7.304
Carbonates, lime and magnesia; Phosphates, lime, magnes. and iron; Peroxide of iron	2.100	1.414
Loss	2.400	2.886
	1,000.000	1,000.000

Denis found the proportion of water in man's blood to vary from 805 to 732 in a thousand parts, and in woman from 848 to 750. According to Lecanu, the quantity of water bears no determined relation to the period of life. Denis, however, found it more abundant in children, and in aged persons. In sanguine temperaments the blood has less water in it than in lymphatic.

The proportion of albumen varies from 57.890 to 78.270, and is about the same in the two sexes. The crassamentum consisting of the red globules and of fibrin varies from about 68.349 to 148.450, and in men it is more abundant than in women, in the proportion of 32.980 parts in the thousand.[1]

[1] For very erudite and interesting essays on the blood in regard to its corpuscles, liquor sanguinis or plasma, quantitative analysis, development, regeneration, and other points connected with it—a full account of which would be too long for the present work—the reader is referred to the writings of Hewson and Hunter, in the last century. Henle's Gen. Anat. p. 457, et seq Paris, 1843. Müller's Physiology, by Baly, p. 109, et seq. vol. i London, 1842. Principles of Human Physiology, by W. B. Carpenter, p. 517, et seq. Philada. 1850. Wagner's Elements of Physiology, by Willis, p. 230, London, 1842. Animal Chemistry by Dr. J. F. Simon, Phila. 1846.

BOOK VIII.

PART II.

OF THE SPECIAL ANATOMY OF THE CIRCULATORY SYSTEM.

CHAPTER I.

OF THE HEART AND PERICARDIUM.

The Heart (*cor*), the centre of the circulation, is situated in the thorax, between the sternum and the spine; being bounded on its sides by the lungs, and below by the tendinous centre of the diaphragm. It is a hollow muscular organ.

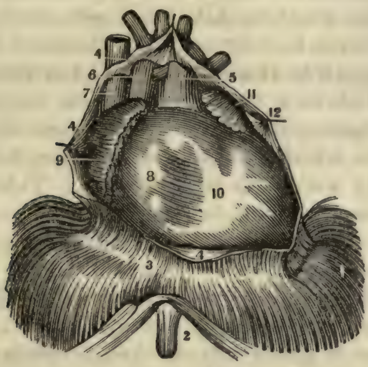
The heart is of a conoidal shape, but flattened on the surface which lies upon the diaphragm. This flat surface is on a horizontal line with the lower end of the second bone of the sternum; the base of the cone is towards the vertebræ, and looks obliquely backwards to the right side, while the apex is about the junction of the left fifth rib with its cartilage. Its common weight is about six ounces. Its greatest length, to wit, that from the apex to the base, is about five and a half inches, four of which are taken up by the ventricles: its base is about three and a half inches in diameter.

The heart is divided into four cavities; two auricles (*atria*) and two ventricles (*ventriculi*): the places where the partitions are placed between these cavities are marked on the surface of the heart by fissures or depressions, sufficiently distinct to be immediately recognized. The depression between the auricles and the ventricles is the sulcus circularis, and that between the ventricles the sulcus longitudinalis. The two auricles form the base of the heart; the ventricles constitute its body, and the anterior end of the left ventricle, by being extended somewhat beyond the right, forms the apex (*mucro*), which is sometimes bent a little towards the left side. The right auricle and the right ventricle are the two cavities which are nearest to the right side of the body, while the left auricle and the left ventricle are the two cavities nearest to the left side. It will, however, be understood, from the general observations already made, that the relative situation of these

cavities is such that the right ones are in front of the others, and present obliquely forwards to the right side, while those on the left look obliquely backwards to the left side. This position of the heart makes it encroach more upon the left cavity of the thorax than it does upon the right; from which cause its pulsations may be very easily distinguished where the left ribs join their cartilages, while on the right side of the sternum there is scarcely ever a perceptible pulsation.

The Heart is placed between the right and the left pleura, in the mediastinum, and is surrounded by its own proper capsule called the *Pericardium.* The latter is covered on its sides by the Pleuræ, and

Fig. 225.



An anterior view of the Heart *in situ*, the Pericardium being divided and drawn back.—1. The greater muscle of the diaphragm. 2. The xyphoid cartilage. 3. Tendinous centre of the diaphragm. 4, 4. Section of the pericardium drawn off from the heart. 5. The pulmonary artery. 6. The aorta. 7. Descending vena cava. 8. Right ventricle. 9. Right auricle. 10. Left ventricle. 11. Left auricle. 12. Pericardium.

reposes on the tendinous centre of the diaphragm, to which it adheres by close compact cellular substance, particularly at its periphery. When the latter attachment is cut through, a separation of the remainder is easily effected. Behind, the pericardium is opposite to the bronchia and to the œsophagus.

The pericardium does not adhere to the heart, except at the base of the latter; it is, therefore, a loose capsule in by far the greater part of its extent. It not only surrounds the heart, but also the roots of the large arteries and veins connected with it. Thus, it includes the aorta, as high up as the great vessels proceeding from its arch; from the latter, it passes to the trunk of the pulmonary artery, and also includes it, causing the aorta and the pulmonary artery to lie close together. The posterior face of these vessels is not covered so high up as the anterior face. The pericardium also invests the descending vena cava for an inch above its junction with the right auricle: it likewise invests the trunks of the pulmonary veins, and the ascending cava as it rises above the diaphragm. The pouches which it forms at the base of the heart, in passing from one of these vessels to another, are the cornua of some anatomists. It cannot be considered as pierced for the passage of these vessels, but is lost insensibly on their parietes;

being continued into the cellular covering of the arteries, in accompanying them to a great distance.[1]

The pericardium is a double membrane, or consists of two layers, an internal and external one. The external membrane to which the preceding description is especially applicable resembles strongly the dura mater, but is thinner; it is, therefore, white, semi-transparent, fibrous, and inelastic. Its thickness is greater on its sides than below where it rests upon the diaphragm; or above, where it goes along the great vessels ; its fibres are irregularly disposed and interwoven, but many may be traced longitudinally.

The Internal layer lines the external, and gives the polish to its cardiac surface; it is then conducted along the surface of the several vessels that have been mentioned, to the heart, over the whole of which it is spread, and adheres to it by cellular substance, frequently containing much adipose matter: it also causes the heart to have a smooth shining surface. This is a very delicate thin serous membrane; and secretes a fluid, transparent and somewhat unctuous, like that of the joints, but not so consistent, which lubricates the surface of the heart and permits it to play freely within its pericardium. This fluid, in a natural state, seldom exceeds a teaspoonful, though two ounces, or a little more, are not considered sufficient evidence of a pathological state: its augmentation constitutes a dropsy.

After death, we find the pericardium lying loosely around the heart from the vacuity, and consequently diminished bulk, of the latter; but while the circulation is going on, the heart fills and distends it. A striking resemblance is observable between the condition of the pericardium and the movable articulations. Its external layer corresponds with the strong fibrous capsule that passes from one bone to the other; while the internal is the synovial bag, which scarcely assists in the strength of the apparatus, but secretes a fluid to render motion easy.

Several instances are on record of a total absence of pericardium.

The Right Auricle (*auricula dextra*, *anterior*) is an oblong cuboidal cavity. It is joined at its posterior superior angle by the descending vena cava, and at its posterior inferior angle by the ascending vena cava. The structure of the auricle between these two points seems to be only a continuation of that of the veins. These veins enter with a direction slightly forwards, so that their columns of blood are not directly opposed to each other. In front of this continuation of the two veins, the auricle is dilated into a pouch called its Sinus: the upper extremity of the latter, just in front of the descending cava, is elongated into a process with indented edges, and has some general resemblance to the ear of an animal, from which it is probable that the term Auricle has been derived.

The exterior surface of this cavity is smooth and uniform, but its internal surface is varied at several places. About midway between the orifices of the two cavæ is found a transverse prominence, the Tuberculum Loweri, which is occasioned by the continuous structure of the veins meeting at an obtuse angle. The right auricle is separated from the left only by a thin septum, which is common to the two. On

[1] Sabatier, Trait. d'Anat. vol. ii. p. 284.

the septum, below its middle, is a superficial circular depression, the Fossa Ovalis; it is more distinct above than below, and varies much in its dimensions. It is surrounded by an elevated margin, composed of muscular fibres, and called its Annulus, or the Isthmus of Vieussens. The septum of the auricles is thinner at the fossa ovalis than elsewhere, and is frequently perforated by one or more oblique foramina. I have, on several occasions, seen a hole there, large enough to transmit the finger. In such cases, from the valvular arrangement of the opening, it is probable that the blood of the two auricles is still kept distinct. In the fœtal state the fossa ovalis always presents this foramen.

Just below the fossa ovalis is found the Eustachian valve, consisting in a duplication of the lining membrane of the auricle. It is crescentic, but varies much in its dimensions and shape. Its left extremity commences at the left inferior margin of the annulus ovalis; it then attaches itself along the anterior semi-circumference of the orifice of the ascending cava, where the latter is connected with the auricle; but is never of an extent sufficient to arrest the circulation there. Sometimes it is reticulated at its margin, and half an inch wide; on other occasions, it is scarcely developed. Its loose edge looks upwards, and to the right side. Its office in the fœtus is clearly, according to the opinion of Sabatier, to direct the blood of the ascending cava through the foramen ovale. In the adult, it may, on the general principle of venous valves, oppose itself to the introduction of refluent blood into the ascending cava; but this office cannot be very exactly performed, as the valve is frequently scarcely visible at that age.

At the lower part of the right auricle, just to the left of the Eustachian valve and very near it, is the orifice of the large coronary vein of the heart: it is protected by a small semilunar valve (*valvula thebesii*), formed also by a duplication of the lining membrane of the auricle. This orifice will admit a quill of common size very readily.

At the anterior semi-circumference of the descending vena cava, there is an oblique fasciculus of muscular fibre, with which the adjoining musculi pectinati are connected, and which in its contraction will answer, to a limited degree, as a valve or barrier, in preventing the reflux of blood from the auricle into the cava. A smaller fasciculus of muscular matter also exists along the base of the Eustachian valve, and will execute the same duty for the ascending cava. The office, however, of neither is perfect, but limited to a partial state of occlusion.

Between the right auricle and the right ventricle is a round hole, of more than an inch in diameter, for the passage of the blood; it is the Ostium Venosum. Its margin, on the auricular side, is smooth and rounded.

The parietes of the right auricle are formed by muscular fibres. On the Sinus these fibres are collected into small transverse fasciculi, called Musculi Pectinati, from their resembling the teeth of a comb. These fasciculi, though slightly united by other fibres, running obliquely and transversely, yet leave between them deep interstices, by which the external and the internal membranes of the heart come into contact. The parietes of the auricle are about one line in thickness. Its muscular structure is continued for a short distance, on the two venæ cavæ.

There are several orifices of small veins on the internal surface of this cavity, and in greater abundance around the fossa ovalis; they belong to the system of coronary vessels, and are the foramina Thebesii.

The Right Ventricle (*ventriculus dexter, anterior*). The general form of this cavity, which receives the blood from the right auricle, is that of a triangular pyramid, curved somewhat backwards, and having its base downwards. It makes the greater part of the anterior surface of the heart, and is about three lines in thickness. It is bounded on its posterior face by the left ventricle, from whose cavity it is completely separated by a thick septum.

The internal surface of this cavity is covered by muscular fasciculi, of very irregular shapes and dimensions, designated under the term Columnæ Carneæ: some of the latter go from one side to the other; others contribute to the mechanism of the valvular apparatus between it and the right auricle; but the greater portion is employed in forming a complicated reticular texture over the internal face of the ventricle. Those connected with the valve vary from four to eight in number: they are rounded, of different lengths and sizes, and detach from their projecting extremities several small rounded tendinous chords (*chordæ tendineæ*), which are inserted into the floating edge of the valve, or near it. These chords form an intertexture among themselves, and along with the influence of the columnæ carneæ serve to brace up the valve in its action.

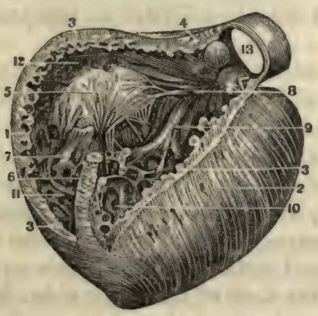
The Valve, between the ventricle and the auricle, consists in a duplicature of the lining membrane of the ventricle, arising uninterruptedly from around the ostium venosum, at the left margin, which is there somewhat tendinous. This valve is called the Tricuspid (*valvula tricuspis, triglochis*), because its loose margin is divided into three points or processes. One of these points, which is at the anterior external margin of the orifice, is much larger than the other two and more distinct in its boundaries. The edges of these processes form a sort of reticulated work along with the adjoining ends of the tendinous chords: by this arrangement they are always kept expanded and in the cavity of the ventricle. Muscular filaments have been found in the substance of this valve, coming from the auricle.

The opening for the pulmonary artery is placed above the ostium venosum; at this point the cavity of the ventricle, instead of being reticulated, is made smooth for the more ready transmission of blood. The orifice of the pulmonary artery is round, and about twelve lines in diameter; it is furnished with three valves, called, from their shape, Semilunar or Sigmoid. Each valve is a semicircular plane, formed from the lining membrane of the artery, and attached to the latter by its semi-circumference. The diameter of the plane is loose, and instead of being straight has each semi-diameter of a curved or festooned shape: in the centre of its edge is a small cartilaginous body, the Corpusculum Aurantii or Nodulus Aurantii, which, when the valve is thrown down by the reaction of the artery, comes in contact with the corresponding bodies of the other valves, so that they serve as mutual abutments. The Corpusculum is sometimes scarcely discernible, being merely a little thickening of the valve. Between the outer face of

each valve and the artery there is a pouch, attended with a slight dilatation of the artery, and called the Sinus of Valsalva. Between the coats of each valve there is an additional fibrous substance, for the purpose of strengthening it.

The Pulmonary Artery, immediately after its origin, goes upwards and backwards to the under part of the curvature of the aorta, and there divides into the two trunks, one for each lung. These trunks separate widely, and from the middle of their fork proceeds a ligamentous substance, (the remains of the Ductus Arteriosus of the fœtus,) to the aorta posteriorly to the origin of the left subclavian artery. The right Pulmonary Artery is both longer and larger than the left, and passing transversely behind the aorta and the descending cava, then penetrates the substance of the lung to be distributed as mentioned. The left pulmonary artery passes to the lung in front of the descending aorta. Though the pulmonary artery is quite as large as the aorta, its parietes are thinner.

Fig. 226.



A view of the interior of the Right Ventricle. The rest of it has been removed, but the left ventricle is entire.—2. Left ventricle. 1, 3. Parietes of the right ventricle. 4. Ventricle at the commencement of the pulmonary artery. 5. Anterior division of the tricuspid valve. 6. A portion of the right ventricle. 7, 8. Columnæ carneæ of the right ventricle with their chordæ tendineæ. 9. The right side of the ventricular septum. 10, 11. Recesses between the bases of the columnæ carneæ. 12. Appearance at base of tricuspid valve. 13. Interior of the pulmonary artery. Two of the semilunar valves are seen; the third has been removed.

The Left Auricle (*auricula sinistra, posterior*), in the natural situation of the heart, is concealed by the right auricle and the ventricles. Its figure is more regularly quadrangular, or square, than that of the right, and into each of its angles is introduced a pulmonary vein, there being two on each side. Sometimes, however, the two join together previously, so that they have but a common orifice. Its tip, or ear-like portion, is situated at the left side of the pulmonary artery, and is longer, narrower, more crooked, and more notched at its margins than the corresponding portion of the right auricle.

The parietes of this cavity are muscular, and somewhat thicker than those of the right; they are smooth and uniform, both externally and internally, with the exception of its appendix or ear-like portion, in which the musculi pectinati prevail. The term Sinus Venosus or Sinus Pulmonalis of anatomists only means that part of the cavity into which the pulmonary veins empty. The septum between the auricles, when viewed on this side, has the place of the fossa ovalis marked out prin-

cipally by its diaphanous condition. Occasionally, there is some appearance of the valve which once existed there.

At the inferior part of the anterior side of this cavity is found the opening between it and the left ventricle, also called Ostium Venosum; it is circular, and rather more than an inch in diameter, resembling strongly the corresponding orifice of the right side of the heart.

The Left Ventricle (*ventriculus sinister, posterior*) in the shape of its cavity resembles a long ovoidal or conical body. Its parietes are generally three times as thick as those of the right ventricle, amounting to about eight lines: it is thicker, however, at its inferior than at its superior part, as it gradually decreases in approaching the aorta.

Its internal surface is arranged on the same principle with that of the right ventricle, being roughened by the presence of numerous fleshy columns (*columnæ carneæ*), some of which are connected with the valvular apparatus between it and the left auricle: others form an intricate reticular texture on its sides, and a few pass from one side to the other. As this surface approaches the orifice of the aorta, it becomes smooth, so that no impediment may be afforded to the passage of the blood.

The Ostium Venosum, on the side of this cavity, has its margin looking tendinous, and furnished with a duplicature of the lining membrane that surrounds it. This duplication, by being severed on its loose edge into two divisions, obtains the name of Mitral Valve (*valvula mitralis*). Its margin is secured from being pushed into the left auricle by numerous chordæ tendineæ, which are attached by their other extremities to four or five columnæ carneæ projecting from the surface of the ventricle. The whole internal arrangement of this cavity indicates a great increase of strength over that of the right side: in the robustness of its fleshy columns; the number and size of its tendinous chords; the care with which they are fixed to the margin and near it, of the valve, and the greater thickness of its valve. The upper division of the mitral valve is placed immediately below the orifice of the aorta, and is considerably broader than the other, so that when it opens to admit blood, it is in some measure thrown over the aortic orifice. There is less of an intertexture among the tendinous chords here than on the right side of the heart: they cluster more, and, owing to the breadth of the extremities of the fleshy columns, are more parallel.

The Septum of the Ventricles is of considerable thickness, being formed almost exclusively by the continuation of the fibres of the left ventricle. Where the large columnæ carneæ elevate themselves on its surface, its thickness is increased. Its shape is somewhat triangular. It forms a round projection into the right ventricle, while its other surface, which presents to the left, is concave to the same degree. It is rather thinner as it approaches the auricular septum than elsewhere. Its fibres near the apex are less closely connected to each other.

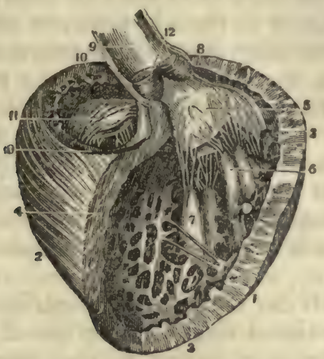
The orifice of the Aorta is furnished with three Semilunar Valves,

[1] Mr. Erskine Hazard has furnished me with the following estimate on the action of these valves:—

If the diameter of the artery be put = 10, the length of the superior edge of the valve will also be 10. The *arc* occupied by the valve will be 10.47 = 120° of the circle. The

which, in the mode of their arrangement, correspond precisely with those of the pulmonary artery. They are, however, thicker, and the Corpuscula Aurantii are larger. The Sinuses of Valsalva, attended with a slight dilatation of the artery, exist in the same way. Just beyond the margin of the right and of the left valve, are observed the orifices of the two coronary arteries. The orifice of the aorta is somewhat tendinous, which marks out the distinction of structure between it and the ventricle.

Fig. 227.



A three-quarter view of the Left Ventricle after the removal of its anterior wall.—1, 3. Left side of the left ventricle. 2. Right ventricle. 4. Right side of the left ventricle. 5. The mitral valve. 6, 7. Two of the columnæ carneæ with their chordæ tendineæ as attached to the valve. 8. Cut edge of the ventricular paries at the origin of the aorta. 9. Cavity of the aorta. 10, 10. Section of the superior surface of the right ventricle, showing the ostium venosum and tricuspid valve from above. 11. Tricuspid valve. 12. Two semilunar valves of the aorta.

Of the Texture of the Heart.

The Heart, with the exception of the serous membrane which lines its cavities, (called the Endocardium,) and of the serous lamina of pericardium which covers its surface, consists almost entirely of muscular fibres.

The sides of the auricles, as stated, are much thinner than those of

valves, when open, will either assume the form at B, or that of the double chord of 60°, as at A. In either case, being .47 shorter than the arc, they cannot come in contact with it,

Fig. 228.

and must, therefore, leave room for the blood to get behind them, and depress the valves. For the same reason, they cannot close the orifice of the coronary arteries. The chord of 120° would be 8.67.

the ventricles. In the right auricle, the stratum of múscular fibres is uniform in its venous portion, but on the sinus is arranged into the parallel fasciculi called the Musculi Pectinati; a circular fasciculus surrounding, as stated, the orifice of the descending cava. In the left auricle, the stratum of muscular fibres forms a uniform layer, and is also thicker than on the right side. These fasciculi commence on the pulmonary veins and run transversely across the auricle, with the exception of the more deeply seated, which are irregular, and crossed upon each other. The septum of the auricles is also formed by a muscular stratum.

In the ventricles, the superficial fasciculi observe a spiral course, and many of those belonging to the left ventricle may be traced over the right; as the fibres are more deeply situated, they become shorter and more interwoven. In the septum, between the ventricles, the fibres of the two cavities are much interlocked; but with some trouble may be partially separated. The fibres of the columnæ carneæ are too irregular in their course to admit even of a general description. It would appear, however, that they are a continuation of the superficial spiral fibres of the ventricles which penetrate into the interior of the heart. At its apex, they leave a small foramen which is closed only by the pericardium externally, and the lining membrane of the heart. M. Gerdy asserts that all the fibres of the ventricles arise from, and are inserted into, the tendinous rings forming the ostia venosa and the orifices of the large arteries; having in the mean time traversed the course which is peculiar to the several fasciculi, according to their being superficial; in the middle, or deep-seated.[1]

All the cavities of the heart are lined by the serous membrane *endocardium*. And it resembles that of the blood-vessels. It is the duplicature of this with intermediate fibrous tissue which in each case makes the valves, the thickness of which is proportionate to the requirements of the circulation.

Of the Blood-Vessels of the Heart.

The Heart is furnished with both arteries and veins, which belong to its nutritious system.

The Arteries called Coronary, arise, as observed, from the trunk of the aorta, somewhat above the free margins of the semilunar valves; so that, when the latter are applied against the aorta, the orifices of these arteries are still visible.

The Right Coronary Artery begins above the anterior valve, and passes to the right, beneath the pulmonary artery; it then shows itself in the upper part of the fissure, between the right auricle and right ventricle, and follows the course of this fissure to the flat side of the heart. It detaches, as it goes along, several small branches, which come off at right angles from it. One set of these branches is distributed upon the right ventricle, and another set upon the right auricle. Small branches are also sent from it to the root of the pulmonary artery, and to that of the aorta.

[1] For a very detailed exposition of the structure of the heart, see Wolff, Act. Acad. Petrop. 1781; and Gerdy, Journal Complémentaire du Dict. des Sc. Med. vol. x. p. 97.

The Left Coronary Artery begins above the left semilunar valve. While its root is still obscured by the pulmonary artery, it divides into two principal branches, of which the anterior runs in the fissure on the upper part of the septum of the ventricles to the apex of the heart, and in this course distributes branches to the right and left ventricle: those to the right anastomose with the branches of the right coronary artery, which go to the same ventricle. The other branch goes along the groove, on the septum, between the left auricle and the left ventricle, and reaches the under surface of the heart, and in this course distributes many branches to the left auricle and left ventricle, both on their upper and under surfaces. It anastomoses freely with the branches of the trunk that run along the upper part of the septum.

In consequence of the frequency of the anastomoses between the two coronary arteries, injecting matter thrown into one very readily finds its way into the other.

The Coronary Veins receive the blood, which is distributed by the coronary arteries through the substance of the heart.

The Great Coronary Vein (*vena coronaria maxima cordis*) is formed by the union of several trunks, which run from the apex towards the base of the heart. One of them begins at the apex, goes along the superior fissure of the septum of the ventricles, and then winds to the left side, between the left auricle, and the left ventricle: while in the latter position, it is joined by several trunks coming from the left ventricle and the left auricle: it finally empties into the lower part of the right auricle, just in front, as mentioned, of the orifice of the ascending cava; being there masked by its own valve.

The Lesser Coronary Vein (*vena coron. minor cordis*) lies in the inferior fissure of the septum of the ventricles. It begins at the apex, and, going backwards, collects the blood from the flat surface of the heart, principally on the right ventricle. It discharges into the great coronary vein, just before the latter terminates in the auricle.

Besides the preceding veins, some of a smaller size exist on the right ventricle and auricle, and about the root of the aorta and pulmonary artery, and empty by several orifices into the right auricle. There are also some veins of a still smaller size, which open into all the cavities of the heart by little orifices, called the Foramina of Thebesius. By Mr. Abernethy they are considered as being larger when the lungs are diseased.[1]

The Nerves of the Heart come principally from the cervical ganglions of the sympathetic, and follow the course of the coronary arteries. It has been doubted whether these nerves are actually distributed in the substance of the heart, from the presumption that, as they cannot be traced beyond the third order of branches of the coronary arteries,

[1] London Philosophical Transactions, 1798.

they are limited to them. But, as the ramifications of the sympathetic are bestowed exclusively upon the branches of the circulatory system, Meckel has very properly suggested that the heart being also supplied with nerves from the same source, it follows that there can be no departure from the general rule, as the heart is nothing more than the fibrous portion of the blood-vessels more completely developed.

While the circulation continues, as both auricles contract at the same instant, whereby the blood is thrown into the ventricles, and as immediately afterwards the ventricles contract simultaneously also, whereby the blood is forced into the aorta and the pulmonary artery, so it is the contraction of the ventricles which causes the heart to strike against the parietes of the thorax. For, as was first pointed out by Dr. W. Hunter, the blood which is forced through the large arteries, by extending them, diminishes their curvature, or brings them more into a straight line, in which effort the heart bounds up from the tendinous centre of the diaphragm. The filling of the auricles, while this is going on, also assists in protruding the heart forwards. The French anatomists assert that, during the contraction of the ventricles, their extremity is elevated or bent upwards on the body of the heart, which will also increase the momentum of the stroke against the thorax.

CHAPTER II.

OF THE ARTERIES.

SECT. I.—THE AORTA AND THE BRANCHES FROM ITS CURVATURE.

THE Aorta is the trunk of the arterial system. Having arisen from the superior posterior end of the left ventricle, its root passes beneath the pulmonary artery, and is entirely concealed in front by it. Keeping to the right, it emerges at the base of the heart, between the right auricle and the trunk of the pulmonary artery, being bounded on the right side by the descending cava. Continuing its ascent, it forms a curvature with the convexity upwards, and the summit of which rises to within eight or twelve lines of the superior edge of the sternum. This curvature is in front of the third and fourth dorsal vertebræ, and its direction is nearly marked out by a line drawn from the anterior extremity of the third right rib, to the posterior end or tubercle of the third one on the left side. In this course, therefore, the aorta passes over the right pulmonary artery, across the left bronchus, and applies itself to the left side of the spine, about the third or fourth dorsal vertebra. It is this curvature which obtains the name of the Arch of the Aorta (*arcus aortæ*).

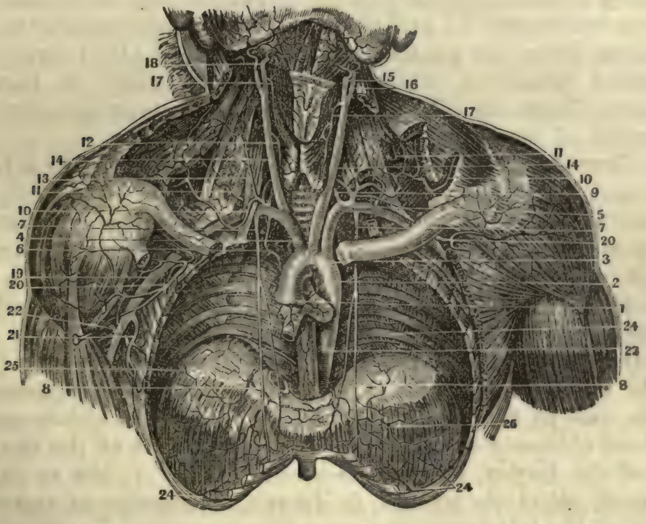
Near its origin, where the aorta is still within the pericardium, it has very commonly, especially in persons advanced in age, a dilatation, which is called the *Great Sinus*, to distinguish it from the lesser sinuses, or those of Valsalva. This dilatation is useful in diminishing the re-

sistance arising from the curvature of the aorta, to the current of blood; or rather it is a provision for doing away with the effects of friction, as by it a larger current of blood becomes a compensation for diminished velocity. The ascending portion of the arch is to the right of the vertebral column, the descending portion to the left, and the middle or horizontal part goes in front of the trachea.

The aorta, in its descent of the thorax, is placed in the posterior mediastinum, and is covered on one of its sides by the left pleura, while the other side is in contact with the left surface of the bodies of the dorsal vertebræ. At the lower part of the thorax, it inclines towards the middle line of the vertebræ, in order to reach the hiatus aorticus of the diaphragm, through which it penetrates to the abdomen. In the abdomen it descends in front of the lumbar vertebræ, somewhat on their left side; and at the intervertebral space between the fourth and fifth vertebræ of the loins, or some little above, it ceases, by being divided into two large trunks, the Primitive Iliacs, one for each lower extremity, and for the corresponding side of the pelvis.

In this course of the aorta, from the heart to the loins, it first gives off the branches which supply the head and the superior extremities; then, those which supply the sides of the thorax: afterwards, in the abdomen, it detaches the trunks which supply the viscera and the sides of the latter cavity.

Fig. 229.



A view of the Arteries of the Chest and Neck.—1. The aorta at its exit from the heart. 2. Descending portion of its arch. 3. Summit of arch of the aorta. 4. Arteria innominata. 5. Left subclavian artery. 6. Artery for thymus gland not usual. 7, 8. Internal mammary artery. 9. The vertebral artery. 10. The superior scapular artery; it goes to the supra-spinatus muscle through the coracoid notch. Its point of origin here is within the scaleni, being not the most common. 11. Transverse cervical. 12. Inferior thyroid artery seen on the body of the gland. 13. The anterior cervical. 14. Primitive carotid on the neck. 15. Internal carotid. 16. External carotid. 17. Superior thyroid artery. 18. Arteria facialis. 19. Arteria axillaris. 20. Superior thoracic. 21. Axillary thoracic. 22. Posterior circumflex. 23. Descending aorta. 24, 24. Intercostal arteries. 25. Distribution of the phrenic arteries upon the diaphragm.

The Coronary Arteries are, strictly speaking, the first branches of the aorta, but as they belong especially to the heart, their description is associated with it. In all the space between them and the superior

convexity of the aortic arch no branches are given off; but as the aorta is crossing the trachea three considerable trunks arise from it, which are distributed upon the head and the upper extremities principally. They are, the Arteria Innominata, the Left Primitive Carotid, and the Left Subclavian.

The *Arteria Innominata* is first in its origin: in ascending from left to right in front of the trachea, and behind the Transverse vein, it crosses the trachea very obliquely; is from an inch to an inch and a half, and sometimes, though rarely, two inches long, when it divides into the right subclavian and the right primitive carotid. The left primitive carotid arises from the aorta, close upon the left border of the innominata, frequently, indeed, from a part of it. The left subclavian artery, at its origin near the left carotid, generally leaves a distinct interval of one, two, or three lines. The relative situation of these trunks is particularly alluded to in the account of the superior mediastinum. The last two are, of course, longer than the corresponding trunks of the right side, by the whole length of the arteria innominata. With the exceptions connected with their mode of origin, the arterial trunks of the two sides are exactly alike, and have the same mode of distribution.

The exact curve of the aorta is not regular; when properly distended, it will be found that to the right of the innominata there is a sort of angularity about it, and that to the left of the left subclavian there is the same conformation: and there a second dilatation occurs. These dilatations favor the progress of the current of blood upon common mechanical principles, while the part intermediate to them, being straighter, favors the filling of the three large branches coming from the summit of the arch.

The Common Carotid Artery (*carotis primitiva*), being a branch of the innominata on the right side, and of the aorta on the left, goes up the neck to terminate just below the cornu of the os hyoides. In the early part of its course, the right one is more inclined outwardly than the left, owing to its origin from the arteria innominata in front of and to the right side of the trachea; whereas, the left ascends almost vertically.

At the lower part of the neck, just above the sternum and the clavicle, the carotid is covered by the sterno-hyoid and sterno-thyroid muscles, and by the sternal portion of the sterno-cleido-mastoid. It is crossed obliquely on a line with the lower part of the thyroid cartilage of the larynx, by the omo-hyoid muscle. It lies at the side of the thyroid gland, the trachea, the larynx, the œsophagus, and pharynx; in front of the transverse processes of the cervical vertebræ, and the longus colli muscle; having on its outer margin, but somewhat in front, the internal jugular vein and the pneumogastric nerve, enclosed in the same sheath, and the sympathetic nerve behind. At the side of the larynx, the carotid is very superficial, and with the exception of being crossed by the omo-hyoideus muscle, it is only covered by the platysma myoides and the integuments.

The Carotid, having got as high as the space between the os hyoides and the thyroid cartilage, but varying slightly in different subjects,

there divides into two large trunks, the Internal Carotid, which goes to the brain and to the eye; and the External Carotid, which is principally distributed upon the more superficial parts of the head and neck. The first of these trunks is placed behind the other, and bends outwardly at its root: it is generally the largest in infancy, on account of the proportionate volume of the brain at that age; it is also swollen at its root, so as to form a sinus there, resembling an incipient aneurism. No branch, except in the *abnormous* cases, is given off from the common carotid between its origin and bifurcation.

SECT. II.—OF THE CAROTIDS, AND THEIR BRANCHES.

The Internal Carotid (*arteria carotis interna*), in the adult, is smaller than the external, and extends from the larynx to the sella turcica. It ascends between the external carotid and the vertebræ of the neck, being in front of the internal jugular vein, and having the pneumogastric nerve at its outer margin: as it gets on a level with the base of the lower jaw, it is crossed externally by the digastric and the stylo-hyoid muscles; it is immediately afterwards concealed in the subsequent part of its ascent by the ramus of the lower jaw. Having gone along the most internal or deeply seated margin of the parotid gland and of the styloid process of the temporal bone, at the side of the superior constrictor of the pharynx, it then penetrates into the cranium through the carotid canal of the temporal bone.

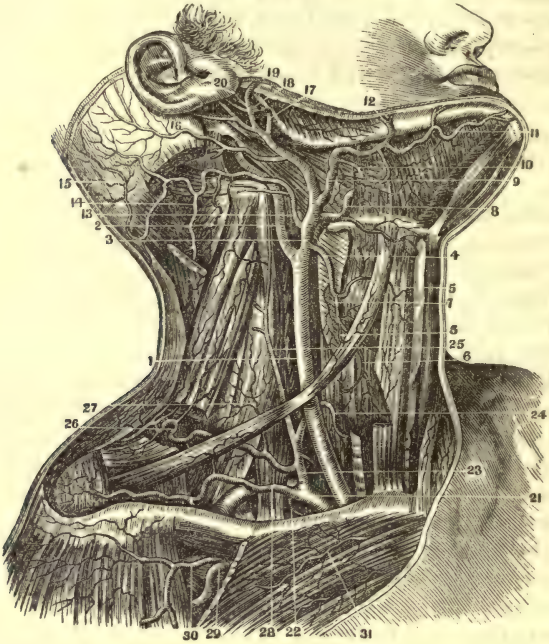
It is slightly flexed between its origin and the carotid canal: just before it reaches the latter, it curves upwards and forwards. The first part of its course through the canal is vertical; afterwards it goes horizontally forwards; and to escape from the canal it has once more to ascend almost vertically, which brings it to the posterior extremity of the Sella Turcica. On the side of the Sella Turcica it again passes horizontally forwards through the cavernous sinus; and at the anterior clinoid process it once more ascends, and, having penetrated the dura mater, it reaches the brain.

In this passage, through the carotid canal, it is attended by the upper extremity of the sympathetic nerve, and gives one or more small branches to the petrous bone; it also gives a few branches to the dura mater and to the nerves about the cavernous sinus. But, for the full exposition of the distribution of the internal carotid, see the arteries of the Brain and of the Eye.

The External Carotid Artery (*art. carotis externa*) extends from the termination of the primitive carotid to the neck of the lower jaw. In the early part of its course, where it is situated in front of the internal carotid, and between the pharynx and the sterno-mastoid muscle, it is comparatively superficial, being only enveloped by its sheath, and covered by the platysma myoides and the skin. Just above this place it is crossed externally by the hypoglossal nerve, which detaches the descending branch along the front of its sheath and of that of the primitive carotid. Somewhat above this nerve, it is also crossed externally by the digastric and the stylo-hyoid muscle, and lies there on the side of the superior constrictor muscle of the pharynx, near the tonsil gland. About its

middle, it is crossed internally by the stylo-glossus and the stylo-pharyngeus muscle; it then ascends through the substance of the parotid gland, not far from its internal margin between the ramus of the lower jaw and the ear, to its termination.

Fig. 230.



A view of the Arteries of the Neck and Shoulder on right side.—1. Primitive carotid artery. 2. Internal carotid artery. 3. External carotid artery. 4. The superior thyroid artery. 5. Branches of to the muscles. 6. Main branch to the gland. 7. Pharyngeal branch. 8. Lingual artery. 9. Facial artery. 10. Its branches to the submaxillary gland. 11. Sub-mental branch. 12. Trunk of the facial as it goes over the jaw. 13. Occipital artery. 14. Branches of to the muscles on the back of the neck. 15. Main trunk to the occiput. 16. Posterior auricular artery. 17. A branch of external carotid cut off, which goes to the parotid gland. 18. Origin of the internal maxillary artery. 19. Origin of the temporal artery. 20. External ear. 21. The right subclavian. 22. Origin of the internal mammary. 23. Trunk of the inferior thyroid, from which arise in this subject the anterior and posterior cervical arteries. 24. Branch of the inferior thyroid going to the thyroid gland. 25. Anterior cervical going up the neck. 26. Posterior or transverse cervical. 27. Branches to the scaleni and levator scapulæ muscles. 28. The superior scapular artery. 29. The thoracica superior of the axillary artery. 30. Thoracica acromialis. 31. Branches to the great pectoral muscle.

Several very important branches are given off from the external carotid; they are as follow:—

The Superior Thyroid Artery (*art. thyroidea superior*) arises from the external carotid, about a line above its root, and is distributed to the larynx and to the thyroid gland. It goes at first inwards and forwards on the side of the larynx, being covered by the omo-hyoideus muscle, and by the platysma myoides; it then descends under the sterno-thyroideus to the upper margin of the lobe of the thyroid gland. In this course it performs several flexuosities, of considerable variety in different individuals.

The Laryngeal Branch comes from it near the superior margin of the thyroid cartilage; this branch glides in between the thyro-hyoid muscle and the middle thyro-hyoid membrane or ligament; after a short

course, it penetrates the latter, and is then distributed in a great number of small twigs to the muscles and to the lining membrane of the larynx. A small trunk, either from the laryngeal branch or from the thyroid artery itself, is spent upon the crico-thyroid muscle, and, traversing the front surface of the middle crico-thyroid ligament, anastomoses with its fellow: small twigs from this branch penetrate to the interior of the larynx through the middle crico-thyroid ligament. Sometimes this crico-thyroid ramus is superior in size to the one above; in which case it principally supplies the interior of the larynx.

The Thyroid Branch is the continuation of the principal trunk. It penetrates into the substance of the thyroid gland, and divides into two ramuscules, one of which goes along the posterior face of the lobe of the gland, and anastomoses with the inferior thyroid artery; the other goes along the upper margin of the gland, and anastomoses with its congener of the opposite side. The thyroidal artery is split up into a great many branches in the substance of the gland; it also sends small branches to the pharynx, œsophagus, and the little muscles on the front of the neck.

The Lingual Artery (*art. lingualis*) comes from the external carotid at the distance of from six to twelve lines above the superior thyroid, and goes to the tongue. It is concealed in the early part of its course by the digastric and the stylo-hyoid muscles; it then penetrates the hyoglossus muscle just above the cornu of the os hyoides, or goes between it and the middle constrictor of the pharynx. It then ascends between the hyoglossus and the genio-hyoglossus muscle; and advancing forwards, is placed between the latter and the sublingual gland, and finally reaches the tip of the tongue.

The lingual artery sends off the following branches. At the root of the tongue one or more trunks arise from it, the *Dorsales Linguæ*, which go to the base of this organ, the tonsils, the epiglottis, and the soft palate; the latter is called the Inferior Palatine (*palatina inferior*). A little farther on, the lingual detaches another branch, the *Ramus Sublingualis*, which, advancing between the mylo-hyoid and the genio-hyoglossus muscle, and above the sublingual gland, sends a great many ramifications to these parts and to the lining membrane of the mouth; it is sometimes a branch of the facial. The *Ramus Raninus* is the continuation of the lingual; it advances between the lingualis and the genio-hyoglossus muscle, to the tip of the tongue, distributing continually its twigs on each margin, and ends there by anastomosing with the corresponding artery of the other side.

The Facial Artery (*arteria facialis, maxillaris externa*) arises from the external carotid two or three lines above the lingual, and is spent principally on the side of the face below the eye. It is of considerable size, and very tortuous; its root is concealed by the stylo-hyoid and the digastric muscle, and it is traversed externally by the hypoglossal nerve. It goes forward within the angle of the lower jaw, and above the submaxillary gland, but very much connected with it: it then mounts over the base of the maxilla inferior, at the anterior margin of the masseter muscle, and afterwards shapes its course, in a serpentine manner,

to the internal canthus of the eye, passing between the muscles and the integuments of the face. In this course, the facial artery sends off the following branches.

As it passes by the submaxillary gland, it sends several twigs to it: previously it also sends several little branches to the contiguous muscles, as the internal pterygoid, digastric, and so on; but they are too small to be of much consequence.

The Sub-mental branch arises, then, on a level with the base of the lower jaw; it advances forwards under the origin of the mylo-hyoideus, and above the anterior belly of the digastricus. It sends several branches to these muscles, some of which anastomose with the ranine artery; behind the symphysis of the jaw, it anastomoses with its fellow; it then mounts over the chin, to which and to the lower lip it is distributed, anastomosing there with the inferior coronary artery of the mouth, and with the inferior maxillary which comes out from the anterior mental foramen in the lower jaw.

When the facial artery has got upon the face, it sends backwards a small branch to the lower part of the masseter muscle. Somewhat above this, it sends forwards a branch called the Inferior Labial, which is distributed upon the middle of the chin. When it gets on a level with the corner of the mouth, but sometimes lower down, it sends forward, under the depressor anguli oris, the Inferior Coronary Artery, to the lower lip, which frequently supplies the place of the inferior labial entirely; but when the latter is large, the coronary is small in proportion; a few lines higher up the facial sends forward a third branch, the Superior Coronary, which goes to the upper lip. These coronary arteries are very tortuous, and are distributed by many branches in the substance of the lips; by anastomosing with their congeners of the other side, they surround the mouth completely. The superior coronary artery, as it passes under the nose, sends upwards one or more small branches to the integuments of its orifice and septum.

After this, the facial artery, in ascending towards the internal canthus of the eye, sends a branch to the ala nasi (*art. alaris nasi*), and another to anastomose with the infra-orbitar artery. It finally terminates at the internal canthus of the eye by anastomosing with the branches of the ophthalmic, which come out there upon the side of the root of the nose. Several ramuscules, which are too small to merit special description, are given by the facial to the integuments and muscles of the face, and to the lower eyelid.

The Inferior Pharyngeal Artery (*art. pharyngea inferior*, *ascendens*) is one of the smallest of the original branches of the external carotid, and generally arises opposite to the lingual; but there is much variety in the latter respect, it being sometimes higher up or lower down, and not unfrequently a branch of one of the other arteries, instead of being an original trunk. It ascends on the side of the pharynx, between the external and the internal carotid, and is covered by the stylo-pharyngeus muscle. It is principally distributed on the constrictor muscles of the pharynx, and upon their lining membrane. But one of its branches, called the Posterior Meningeal Artery, ascends through the

posterior foramen lacerum of the cranium, between the jugular vein and the pneumogastric nerve, and is distributed on the contiguous dura mater.

The Occipital Artery (*arteria occipitalis*) is a very considerable trunk, which comes from the external carotid, generally opposite to the facial, and is spent upon the integuments, on the back part of the head.

At its root, it is deeply situated in the side of the neck, below the parotid gland, and has the internal jugular vein and the par vagum on its inside. It goes obliquely backwards, in ascending along the posterior belly of the digastricus between the transverse process of the atlas and the mastoid portion of the temporal bone, and is beneath the several muscles which are inserted into the latter, as the sterno-mastoid, the splenius, and the trachelo-mastoid. It is covered, for some distance, by the insertion of the splenius capitis, and becomes at length superficial at the posterior margin of this muscle. The occipital artery is distributed as follows:—

Shortly after its origin, it sends branches to the digastric muscle behind, to the upper part of the sterno-mastoid, and to the lymphatic glands of the upper part of the neck. While enclosed by the muscles on the back of the neck, it also sends branches to them, and anastomoses thereby with the vertebral artery; occasionally, one of these branches is of considerable magnitude, and has been found descending very low on the back, between the splenius and the complexus muscle. It also sends a small branch to the dura mater, through the mastoid foramen generally, but sometimes through the posterior foramen lacerum. When the stylo-mastoid artery is wanting, it also detaches a branch through the stylo-mastoid foramen to the internal parts of the ear.

The occipital artery, having become superficial at the internal margin of the splenius on the occiput, ascends on the latter bone towards the vertex in a tortuous manner, sending off, on each side, many small ramifications. It ends by anastomosing with the posterior temporal artery.

The Posterior Auricular Artery (*art. auricularis posterior*) arises a little above the last, at the lower edge of the parotid gland, from the external carotid, and is one of its smallest branches. It ascends backwards enclosed by the parotid gland, and afterwards between the meatus auditorius externus and the mastoid bone: at the latter place, it sends a ramification to the internal side of the external ear; it then ascends and is distributed, by small branches, on the contiguous integuments of the side of the head. While still involved in the parotid gland, it sends some small ramifications through the meatus externus to its lining membrane and the membrana tympani. It then detaches a branch through the stylo-mastoid foramen, from which the whole artery is also named Stylo-Mastoid; but this branch, as stated, sometimes comes from the occipital. The stylo-mastoid passes along the aqueduct of Fallopius, detaching its arterioles to the tympanum and to the labyrinth.

The External Carotid having given off these trunks, penetrates

vertically through the inner margin of the parotid gland, and gives to it several small twigs. When it arrives on a line with the neck of the lower jaw, it divides into two large trunks; one of them, the Internal Maxillary, goes to the parts within the ramus of the lower jaw; the other, being smaller, is the Temporal Artery.

The Temporal Artery (*arteria temporalis*) continues to ascend through the substance of the parotid, but becomes superficial in front of the meatus externus, in mounting over the root of the zygoma; it is then distributed to the integuments on the side of the head. It frequently sends off one or two ramifications, of but little volume, to the masseter muscle. Just above its root, and while surrounded by the parotid, a branch of some importance, the Transverse Facial (*transversalis faciei*), leaves it, and crosses, horizontally, the masseter muscle, just below the parotid duct, sometimes above it. This branch is distributed to the adjacent integuments and muscles, and terminates in front by anastomosing with the facial and the infra-orbitar artery.

A little below the zygoma, the Middle Temporal Artery (*art. temp. media*) comes off from the Temporal, and ascending with the parent trunk, perforates the temporal fascia at the upper margin of the zygoma, and is distributed to the temporal muscle by many ramifications, which anastomose with the deep-seated temporal arteries. After this, some small twigs, called Auricular, go to the external ear from the trunk of the temporal artery.

The temporal artery, having ascended for an inch or so between the aponeurosis of the temporal muscle and the skin, divides into an Anterior and a Posterior Branch. The former ascends towards the side of the os frontis, and is distributed in ramuscules to the orbicularis palpebrarum, the anterior belly of the occipito-frontalis, and the integuments of the front of the cranium, anastomosing with the frontal artery and the temporal of the other side. The posterior branch is distributed on the integuments of the middle of the side of the cranium, anastomosing with the anterior branch, with its fellow of the other side, and with the occipital artery.

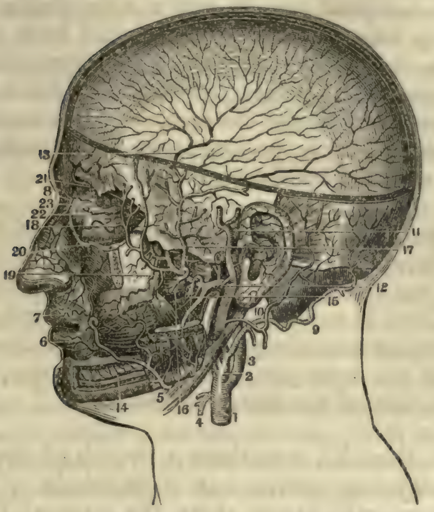
The Internal Maxillary Artery (*arteria maxillaris interna*) winds round the neck of the lower jaw, and, passing between the pterygoid muscles, proceeds in a tortuous manner to the deepest points of the zygomatic fossa. The first part of its course is horizontally inwards; it then ascends in front of the pterygoideus externus to the bottom of the temporal bone, or the spinous process of the sphenoidal: it then passes forwards, within the temporal muscle, to the upper part of the pterygo-maxillary fossa.

It sends off several branches, and commonly in the following order:—

1. The Arteria Tympanica, to the tympanum, through the glenoid fissure.

2. The Arteria Meningea Parva, to the dura mater, through the foramen ovale. It is most frequently a branch of the next.

Fig. 231.



A view of the Internal Maxillary Artery, as given by excisions of the Bones of the Head and Face.—1. Primitive carotid artery. 2. External carotid. 3. Internal carotid. 4. Section of the superior thyroid artery. 5. Point where the facial artery crosses the lower jaw. 6. Inferior coronary artery. 7. Superior coronary artery. 8. Point of anastomosis of facial with the nasal branch of ophthalmic. 9. The occipital artery. 10. Posterior auricular. 11. Temporal artery. 12. Origin of the internal maxillary artery. 13. Meningea magna of the dura mater ramifying over its surface. 14. Inferior dental artery and the alveolar processes of the lower jaw. 15. The pterygoid arteries. 16. The masseter artery. 17. Deep-seated posterior temporal artery. 18. Deep-seated anterior temporal artery. 19. Buccal artery. 20. Infra-orbitar. 21. Supra-orbitar. 22. One of the muscular arteries of eye. 23. Posterior ethmoid.

3. The Arteria Meningea Magna, or Media, to the dura mater, through the foramen spinale. This branch, having entered the cranium, is distributed upon the dura mater in the manner marked off by the furrows upon the internal face of the temporal, the parietal, and the frontal bones. One of its branches enters the aqueduct of Fallopius, through the Vidian Foramen, and is distributed upon the internal parts of the organ of hearing, in anastomosing with the stylo-mastoid artery.

4. The Arteria Maxillaris, or Dentalis Inferior, descends along the internal face of the ramus of the lower jaw, and, having sent off some ramifications of small size to the contiguous muscles and the lining membrane of the mouth, it enters the posterior mental foramen with the inferior dental nerve. Going along the canal in the substance of the lower jaw, it detaches successively from its superior margin, ramifications to the teeth. At the anterior mental foramen, a trunk is sent forward as far as the symphysis, which supplies in its course the canine and incisor teeth; the remainder of the inferior maxillary artery comes out at the foramen, and supplies the chin, in anastomosing with the facial artery.

5. The Arteriæ Temporales Profundæ are two in number. The first of them, called Posterior, arises next to the inferior maxillary. It is concealed between the external pterygoid and the temporal muscle for

some distance; it then ascends in the posterior part of the temporal fossa, beneath the temporal muscle, and is minutely distributed upon it. The Anterior deep temporal artery is separated from the Posterior, in its origin from the external maxillary, by the pterygoid and the buccal arteries. It arises near the pterygo-maxillary fossa, and, ascending between the temporal muscle and the forepart of the corresponding fossa, is minutely distributed upon the former, in anastomosing with the posterior deep, and with the middle temporal artery.

6. The Arteriæ Pterygoideæ arise after the posterior deep temporal. They vary considerably in regard to number, size, and origin, and are distributed upon the pterygoid muscles, as their name implies. One of their branches, which is sometimes an independent trunk from the internal maxillary, goes between the posterior margin of the temporal muscle and of the neck of the lower jaw, in front of the latter, to be distributed upon the internal face of the masseter muscle.

7. The Arteria Buccalis, sometimes a branch of the internal maxillary, but frequently coming from one of its trunks (either the alveolar or the anterior temporal), passes along the external face of the upper jaw, and distributes its branches to the buccinator and zygomatic muscles, and to the lining membrane of the mouth.

8. The Arteria Maxillaris Superior, or Alveolaris, proceeds downwards and forwards in winding round the tuber of the upper jaw bone. It first sends some ramifications through the bone to the roots of the great and small molar teeth, and to the lining membrane of the maxillary sinus; it then passes forwards along the gums, near the buccinator, and gives ramifications to them and to the contiguous muscles.

9. The Arteria Infra-orbitalis comes from the internal maxillary at the upper part of the pterygo-maxillary fossa; it sends some inconsiderable ramifications to the fat and the periosteum of the orbit, through the spheno-maxillary fissure. It then enters the infra-orbitary canal, and passes through it with the infra-orbitary nerve. On arriving near the anterior orifice of the canal, it detaches downwards a branch which goes to the canine and the incisor teeth, and to the lining membrane of the antrum. It then gets to the face below the origin of the levator labii superioris muscle, and is distributed upon the muscles in front of the upper maxilla, in anastomosing with the facial and with the ophthalmic artery.

10. The Arteria Palatina Superior descends through the posterior palatine canal, and, having reached the mouth, leaves some ramifications with the soft palate: it then advances between the bones and the lining membrane of the roof of the mouth, and disperses itself in several small twigs; one of which passes through the foramen incisivum into the nostril.

11. The Arteria Pharyngea Superior is sometimes a branch of the

last, and is spent upon that portion of the pharynx bordering on the pterygoid processes.

12. The Arteria Spheno-Palatina is the terminating trunk of the internal maxillary: it enters the nose through the spheno-palatine foramen, and divides into two branches, which are minutely distributed over the Schneiderian membrane. One of them descends along the septum narium; the other along the external margin of the posterior naris, and divides into two principal ramuscules, one of which is dispersed along the middle turbinated, and the other along the inferior turbinated bone.

SECT. III.—OF THE SUBCLAVIAN ARTERY, AND ITS BRANCHES.

The Subclavian Artery (*arteria subclavia*) of the right side having arisen from the innominata, and that of the left from the aorta, they each go over the first rib of their respective sides, in adhering closely to it, in the bottom of the interval between the scalenus anticus and the scalenus medius muscle. The right subclavian is much shorter, and more superficial than the left, from its origin to the scaleni muscles. Near the latter they are each covered in front by the sternal end of the clavicle, by the sterno-hyoid and the sterno-thyroid muscle, and by the subclavian vein of the corresponding side; behind they are separated from the vertebral column by the longus colli muscle; below them is the pleura, the left artery being in contact with it for its whole passage in the thorax; and on their internal side is the primitive carotid. The subclavian of the right side is crossed near the scalenus anticus by the par vagum; the phrenic nerve also goes in front of it, but on the internal edge of the scalenus. The subclavian of the left side, having a course almost vertical from its origin to the interval of the scaleni muscles, is nearly parallel with and behind the primitive carotid of that side; the phrenic nerve has the same relative position with it as on the right side; but the par vagum goes parallel with, and in front of the subclavian artery, for some distance along the root of the latter.

At the inner margin of the Scaleni Muscles, the Subclavian, in a short space sometimes called the Thyroid Axis, from its nearness to the thyroid gland, gives off a cluster of trunks; to wit, the Vertebral; the Inferior Thyroid; the Superior Intercostal; the Internal Mammary; and the Posterior Cervical Artery. They sometimes arise distinctly, and after the order mentioned: but there is too great a diversity in subjects to establish any rule on these points.

1. The Vertebral Artery (*arteria vertebralis*) is the most voluminous of the branches of the Subclavian. Immediately after its origin, it ascends on the side of the spine, and enters the canal of the transverse processes of the neck at the sixth vertebra. Pursuing this course, it gets into the cavity of the cranium through the foramen magnum occipitis, and is distributed to the brain in the manner mentioned in the description of that organ.

While in the canal of the transverse processes, it sends off several

branches to the heads of the contiguous muscles, and to the medulla spinalis of the neck. The vertebral artery, like some others, is spindle-shaped, its size augmenting as it recedes from its origin; this imparts some advantage to the current of blood.

2. The Inferior Thyroid Artery (*arteria thyroidea inferior*) arises from the upper face of the subclavian, and goes to the thyroid gland. It ascends at first on the internal margin of the scalenus medius muscle, and then turns suddenly inwards between the vertebræ and the great vessels of the neck.

In this course several unimportant twigs are sent from it to the contiguous parts. Near its root it detaches the Anterior, or the Ascending Cervical Artery, which going up the neck is spent upon the heads of the muscles arising from the transverse processes, as the scaleni, the longus colli, and so on. The inferior thyroidal then gets to the thyroid gland, and is very minutely distributed to it, anastomosing with the other arteries which supply the same organ.

3. The Superior Intercostal Artery (*arteria intercostalis superior*), arising from the under surface of the subclavian opposite the inferior thyroid, descends across the neck of the first rib, and divides into two branches, which supply the two upper intercostal spaces: each of them also sends backwards near the vertebra a small trunk to the muscles of the back.

4. The Internal Mammary Artery (*arteria mammaria interna, thoracica*) descends at first along the internal margin of the scalenus anticus; having then got fairly into the cavity of the thorax, it continues to descend across the posterior face of the costal cartilages, parallel with, and about nine lines from the outer edge of the sternum, between the triangularis sterni and the intercostal muscles.

In this course, besides some distinct twigs to the anterior mediastinum, it sends a branch (*phrenica superior*) which, accompanying the phrenic nerve between the pleura and the pericardium, reaches finally the diaphragm, and is spent upon it. At each intercostal space which it crosses, the internal mammary sends outwards a branch, which is spent upon the fore part of the intercostal muscles and anastomoses with the corresponding intercostal artery: other branches also leave it at each space, which, getting forwards near the sternum, are distributed upon the pectoralis major, and upon the contiguous muscles. The last of these branches, according to M. H. Cloquet, goes transversely across the ensiform cartilage, and, having anastomosed with its fellow, descends between the peritoneum and the linea alba to the suspensory ligament of the liver.

On a level generally with the anterior extremity of the sixth rib, the internal mammary divides into two principal branches; the most exterior of which, descending along the cartilaginous margin of the thorax, is distributed in small twigs to the origin there of the diaphragm and of the transverse muscle of the abdomen. The internal branch reaches the posterior face of the rectus abdominis muscle, and is dispersed upon

it: some of its branches go as low as the umbilicus, to anastomose there with the epigastric artery.

5. The Posterior Cervical Artery (*arteria cervicalis posterior, transversa*) is of a very unsettled origin, but comes most frequently, either from the subclavian itself, or from the inferior thyroid. It is but small in some subjects, owing to its place being supplied by branches from the adjoining arteries.

It crosses horizontally the root of the neck, on the outer face of the scaleni muscles above the subclavian artery. It gets under the anterior margin of the trapezius, and is there divided into two principal branches; the ascending one is spent upon the trapezius and the levator scapulæ; the other descends along the base of the scapula, and is spent in ramifications upon the rhomboidei and the serratus major muscle. Several branches of minor size and importance are sent off from the posterior cervical artery to the muscles on the back of the neck and thorax.

The Subclavian Artery, having sent off the preceding branches, then escapes from the thorax between the scaleni muscles, and gets to the arm-pit between the first rib and the subclavius muscle. The trunk of it is then continued downwards through the axilla, and at the inner side of the arm to the elbow joint.

This great trunk of the upper extremity loses the name of subclavian to be called Axillary Artery (*art. axillaris*), from the subclavius muscle to the lower margin of the arm-pit: and from the latter place to the elbow joint, it is named Brachial Artery (*art. brachialis*). It sends off many interesting branches to the thorax, to the shoulder, and to the arm; and finally terminates a little below or at the elbow joint by bifurcating.

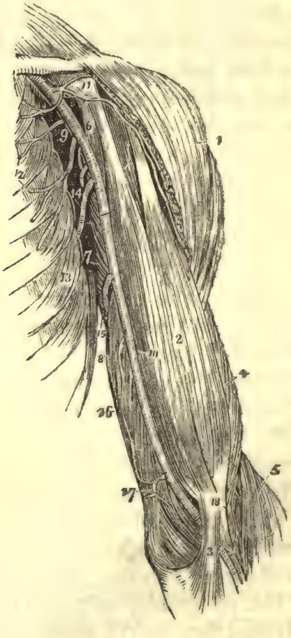
From the scaleni muscles to the elbow, its relative position is as follows: When it first appears between the scaleni, it is bounded above and behind by the collected fasciculi of the axillary plexus of nerves. In front it is separated from the subclavian vein by the insertion of the scalenus anticus. It is placed at the bottom of the depression between the sterno-mastoideus and the trapezius, being covered by the skin, the platysma myoides, and some loose cellular substance below the latter. It then descends between the first rib and the subclavius muscle; escaping from below the latter, it is covered in front by the outer margin of the pectoralis major until it reaches the lower part of the axilla. In this course it has the following relation to other parts: it passes first under the insertion of the pectoralis minor, then under the shoulder joint, then along the internal face of the coraco-brachialis muscle; it has the axillary vein in front of it, and the axillary nerves plaited around it as far down as the coracoid process, when they begin to disperse. This artery, in emerging from the axilla, is placed upon the anterior face of the insertion of the latissimus dorsi; it then runs out the length of the coraco-brachialis, and is afterwards conducted along the inner margin of the biceps flexor cubiti and of its tendinous termination; it lies upon the anterior face of the brachialis internus; and goes beneath the aponeurosis coming from the tendon of the biceps at the bend of the arm. In the

arm it is concealed only by the integuments and fascia, and is bordered internally by the brachial vein and the median nerve.

Of the Branches of the Axillary Artery.

1. The Superior Scapular Artery (*art. dorsalis superior scapulæ*) varies considerably in its origin. Sometimes it is a branch of the subclavian, sometimes of the inferior thyroid, and it frequently comes from the upper part of the axillary, so that it cannot be referred, with strict propriety, to any determined origin. When it comes from the axillary, it is very tortuous, and has to ascend to its destination, which removes it entirely from any interference with the course of the subclavian over the first rib, and over the upper head of the serratus major muscle. But in the other cases, it goes transversely backwards and outwards, somewhat below the posterior cervical, and along the posterior inferior margin of the clavicle, being covered by the sterno-mastoideus, the

Fig. 232.



The Axillary and Brachial Arteries, with their branches.—1. The deltoid muscle. 2. The biceps. 3. The fascia from the tendon of the biceps. 4. Brachialis internus muscle. 5. The supinator longus. 6. The coraco-brachialis. 7, 8. Internal edge of triceps muscle. 9. The axillary artery. 10. The brachial artery. 11. The thoracica acromialis artery. 12. The thoracica longa. 13. The serratus magnus muscle. 14. The subscapular artery. 15. The profunda major artery. 16. The profunda minor. 17. The anastomotica. 18. The profunda major inosculating with the radial recurrent artery.

platysma myoides, and the trapezius; consequently, it is just in the way of the incisions which are made for reaching the subclavian artery, from above the clavicle.

It reaches the superior costa of the scapula near the root of the coracoid process, and passing through the notch there, is distributed, by one large branch, upon the supra-spinatus muscle; and by another, which goes across the anterior margin of the spine of the scapula, to the infra-spinatus muscle. In its course, it sends off several small ramifications to contiguous parts.

2. The External Mammary Arteries (*art. mammariæ seu thoracicæ externæ*) arise from the axillary, between the subclavius and the pectoralis minor muscle. There are four principal trunks, which go uniformly to certain parts, but vary considerably in their origin; for sometimes the latter is distinct in the case of each artery, but frequently otherwise. Their distribution is as follows:—

a. The Thoracica Superior is distributed to the upper part of the pectoralis major muscle, and to the pectoralis minor. Some of its branches reach the mamma in the female, and anastomose with the internal mammary and with the intercostals.

b. The Thoracica Longa descends along the posterior face of the pectoralis major, between it and the serratus magnus. It gives many branches to the lower part of the pectoralis major, to the integuments, and, in the female, to the mamma; anastomosing likewise with the internal mammary and with the intercostals.

c. The Thoracica Acromialis, immediately after its origin, makes for the fissure between the deltoid and the great pectoral muscle, and divides there into an ascending and a descending branch. The former reaches the clavicle, and is partly distributed superficially along it, partly to the contiguous muscles, and to the shoulder articulation. The other branch follows the cephalic vein along the interstice between the deltoides and pectoralis major, and is, finally, distributed to these muscles and to the integuments.

d. The Thoracica Axillaris is irregular, both in regard to the number of its branches and to their origin. Instead of a distinct origin by one or more trunks from the axillary artery, the branches belonging to the name of thoracica axillaris, are sometimes derived from the other thoracic arteries. They are generally distributed only to the fat and the lymphatic glands in the axilla. They occasionally exist primitively as a large trunk, which runs on the scapular face of the serratus major the whole length of the scapula, and is distributed to the adjacent muscles, and to the fat and glands of the axilla.

3. The Scapular Artery (*arteria scapularis communis, sub-scapularis*) arises from the axillary below the shoulder-joint, at or near the anterior margin of the subscapularis muscle. Giving off some inconsiderable branches to the lymphatic glands of the arm-pit, it descends along the anterior margin of the subscapularis, and is distributed to it, to the latissimus dorsi, and to the teres major and minor muscles.

A little below the neck of the scapula, it detaches a large trunk, the Dorsalis Inferior Scapulæ, which, winding around the inferior costa of the bone over the anterior margin of the subscapularis and the teres minor, reaches the fossa infra-spinata. This trunk then divides into

two branches: one of which is distributed superficially between the scapular aponeurosis and the infra-spinatus, and the other more deeply near the dorsum of the bone: one of the ramuscules of the latter ascends beneath the neck of the acromion to anastomose with the Dorsalis Superior Scapulæ.

4. The Anterior Circumflex Artery (*art. circumflexa anterior, articularis anterior*) is about the size of a crow-quill, and arises from the axillary just above the tendon of the teres major and of the latissimus dorsi. It adheres closely to, and surrounds the front of the neck of the os humeri, passing between it, the coraco-brachialis, and the short head of the biceps. It then divides into several branches, some of which go to the deltoides, and anastomose there with the posterior circumflex; others go immediately to the articulation, and either terminate on it, or ascend to the muscles on the dorsum of the scapula, where they anastomose with the scapular arteries.

5. The Posterior Circumflex Artery (*art. circumflexa posterior*) is much larger than the last, and arises from the axillary somewhat below it. It surrounds the posterior face of the neck of the os humeri, passing between it and the long head of the triceps muscle, below the insertion of the teres minor. Many of its ramifications go to the capsular ligament of the articulation and to the muscles adhering to it. But this artery is principally intended for the deltoid muscle, to the internal face of which the most of its branches go. It anastomoses with the anterior circumflex, and with the scapular arteries.

In some cases, the posterior circumflex arises from the axillary below, instead of above, the tendinous insertion of the latissimus dorsi: when this happens, it commonly gives off the arteria profunda major of the arm, and afterwards ascends on the posterior face of the tendon to its appropriate destination.

Of the Branches of the Brachial Artery.

1. The Profound Artery (*arteria profunda major humeri, spiralis*) arises from the brachial, a little below the tendinous insertion of the latissimus dorsi, and having passed downwards, for a short distance, it enters the interstice between the first and the third head of the triceps muscle, winds spirally downwards around the os humeri in company with the radial nerve. On the outer side of the arm, it becomes superficial between the margins of the triceps and of the brachialis internus, and then directs its course between the latter and the supinator longus to the external condyle.

In this course, the artery sends several branches to the triceps muscle, to which, indeed, it is principally destined. Near the external condyle, it supplies the brachialis internus and the heads of the extensor muscles of the fore arm, and anastomoses with the recurrent branch of the radial artery.

2. The Small Profound Artery (*art. profunda minor*) comes from the brachial, two or three inches below the profunda major, but fre-

quently it is only a branch of the latter, and is generally much smaller. It is distributed superficially on the internal face of the triceps at its lower part, and has its terminating branches reaching as far as the internal condyle.

3. The Nutritious Artery (*art. nutritia*) is the next in order from the brachial, and arises from it near the medullary foramen of the os humeri, through which it penetrates, and is distributed to the lining membrane of the bone. It is not larger than a knitting-needle.

4. The Anastomotic Artery (*arteria anastomotica*) arises from the brachial below the last, and is larger than it. It lies upon the lower internal part of the brachialis internus muscle, and crosses the ridge leading to the internal condyle in order to reach the depression between the latter and the olecranon, where it anastomoses with the ulnar recurrent artery.

There is sometimes a second artery here and below the first, called the Anastomotica Minor from its small size.

The preceding is a common arrangement of the branches proceeding from the brachial artery, yet deviations from it are continually met with, in a deficiency or in a redundancy of these collateral trunks, and in their mode of origin. An account of all the varieties would be almost endless, as every subject has some peculiarity.

Several small arteries are also sent from the brachial to the coraco-brachialis, the biceps, the brachialis internus, and to the triceps muscle. They are, for the most part, simply terminal branches, which are too small and irregular to deserve specification.

A division of the brachial artery into two trunks, the Radial and the Ulnar, will be found in a majority of subjects in front of the brachialis internus muscle on a line with the elbow joint: sometimes it occurs nearer the root of the coronoid process. It is, however, common to see this bifurcation much above the elbow. Examples of it have been witnessed at every point between the latter and the arm-pit; in such cases, the course of the radial artery down the fore arm is generally much more superficial than usual, as it is often placed immediately below the skin.

Of the Radial Artery.

The Radial Artery (*arteria radialis*) is smaller than the ulnar, and extends from the elbow to the hand. In the upper half of the fore arm it is placed at the bottom of the fissure between the supinator radii longus and the pronator teres muscle. Having crossed the insertion of the latter, it runs in front of the radius between the tendon of the supinator and of the flexor carpi radialis, reposing on the flexor longus pollicis. Below the styloid process of the radius it runs between the outer end of the carpus and the extensor muscles of the thumb; it then penetrates to the palm of the hand between the root of the metacarpal bone of the thumb and of the fore finger above the abductor indicis muscle.

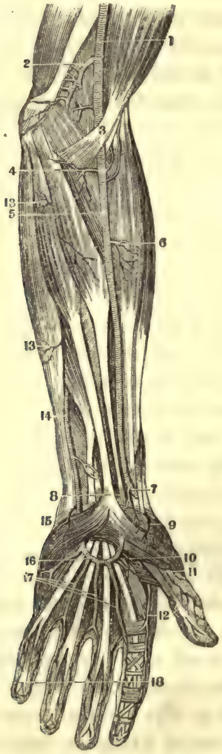
The following branches are sent from the Radial Artery:—

1. The Recurrens Radialis arises at the neck of the radius. It winds, externally, around the joint between the external condyle and the muscles coming from it, and anastomoses with the spiralis of the brachial artery, being distributed in many collateral branches to the joint and to the contiguous muscles.

2. Several small and irregular muscular branches arise from the radial artery, in its progress to the wrist: they have no appropriate names and are terminal.

3. The Superficialis Volæ arises from the radial about the inferior margin of the pronator quadratus muscle. It passes superficially over the process of the trapezium to the muscles of the ball of the thumb, and one of its terminating branches joins the arcus sublimis. Sometimes the superficialis volæ is the principal branch of the radial.

Fig. 233.



Arteries of Forearm and Hand.—1. Lower part of the brachial artery. 2. Arteria anastomotica. 3. Aponeurosis of the tendon of the biceps. 4. Recurrens radialis artery. 5. Radial artery. 6. Muscular branches. 7. Superficialis volæ giving off branches to the muscles of the thumb. 8. The tendon of the palmaris longus inserted into the annular ligament of the wrist joint. 9. Branch of the superficialis volæ on the ball of the thumb. 10. Points to the palmaris profunda. 11. Magna pollicis artery. 12. Radialis indicis. 13. Cubito-muscular arteries. 14. Lower part of the ulnar artery. 15. Branches to the palm and muscles of the little finger. 16. The arcus sublimis. 17. Branches running to supply the fingers. 18. The digital arteries.

4. The Dorsalis Carpi arises from the radial at the carpus, runs across the back of the latter below the extensor tendons, and detaches the posterior interosseous arteries of the back of the hand. They anastomose with branches from the ulnar and interosseous arteries of the fore arm.

5. The Magna Pollicis, a terminating branch of the radial, comes from it in the palm of the hand just at the root of the metacarpal bone of the thumb. It runs beneath the abductor indicis, and at the head of the metacarpal bone divides into two branches which go respectively along the sides of the thumb to its extremity, where they anastomose and terminate.

6. The Radialis Indicis, arising at the same place with the latter, runs along the metacarpal bone of the fore finger, and along the radial side of the same finger to its extremity.

7. The Palmaris Profunda is the third terminating branch of the radial artery. It arises near the same place with the last two, crosses the hand between the metacarpal bones and the flexor tendons; thus forming the Arcus Profundus, from which branches proceed to the interossei muscles; and which ends on the ulnar side of the palm of the hand by a connection with the Arcus Superficialis.

Of the Ulnar Artery.

The Ulnar Artery (*arteria ulnaris*), one of the forks of the brachial at the elbow, passes more in a line with it than the radial artery does. It goes immediately after its origin, under several of the muscles of the internal condyle, to wit: the pronator teres, flexor radialis, flexor sublimis, and palmaris longus, and between the flexor sublimis, and profundus digitorum, being deeply seated; getting from beneath the flexor sublimis, it afterwards runs parallel with the ulna, or nearly so, lying on the flexor profundus between the flexor ulnaris and the ulnar margin of the flexor sublimis, and concealed two-thirds of the way down the fore arm by the overlapping of these muscles. At the thin part of the fore arm, commonly called the wrist, it is superficial, and may be felt pulsating in the living body at the radial margin of the tendon of the flexor ulnaris.

The ulnar artery, at the carpus, takes a very different course from the radial: for it passes over the anterior annular ligament of the carpus just at the radial side of the os pisiforme, to which it is held by a small ligamentous noose; it then proceeds to the palm of the hand. Between the aponeurosis palmaris and the flexor tendons it forms that curve from the ulnar to the radial side of the hand called the Arcus Sublimis. This curve commonly begins a little beyond the anterior margin of the annular ligament, and, presenting its convexity forwards, terminates about the middle of the ball of the thumb at its inner margin.

The branches sent from the ulnar artery are as follow:—

1. The Recurrens Ulnaris arises from the ulnar about the lower part

of the tubercle of the radius, and, winding upwards, is distributed in small branches to the muscles of the internal condyle. One of its ramuscules goes between the internal condyle and the olecranon process, to anastomose with the arteria anastomotica of the humeral.

2. The Interossea arises from the ulnar, just below the other. It is a large trunk, and proceeds but a little distance when it divides into two principal branches, called anterior and posterior interosseal arteries.

a. The Interossea Anterior is much the larger; it runs in contact with the interosseous ligament to the upper margin of the pronator quadratus, giving off branches to the deep-seated muscles of the fore arm in its course. Under the pronator, it perforates the interosseous ligament, and distributes branches to the back of the carpus and of the hand, which anastomose with branches of the radial and posterior interosseal.

b. The Interossea Posterior is sometimes a separate trunk, arising from the ulnar just above the former. In either case, it soon perforates the interosseous ligament to get to the back of the fore arm. Here it sends backwards a Recurrent Branch (*recurrens interossea*) to the back of the elbow, which anastomoses with the recurrens ulnaris and radialis. It then proceeds downwards, being deeply seated and distributed to the different muscles on the back of the fore arm. Some of its branches reach the wrist, and anastomose with the carpal arteries.

3. The ulnar artery, in its descent on the fore arm, sends off many small and irregular muscular branches, called by Professor Chaussier Cubito-muscular: they do not require description.

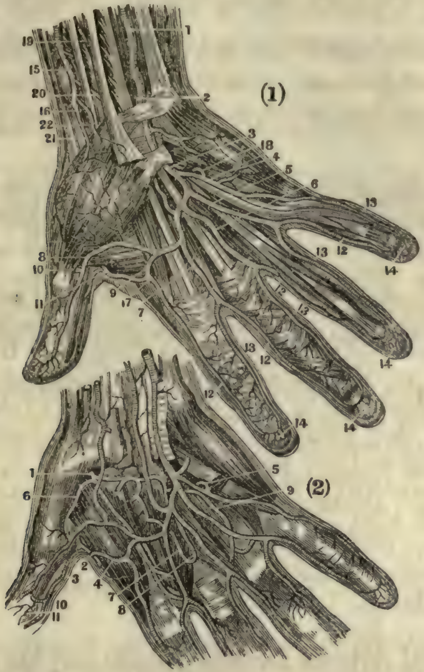
4. The Dorsalis Manus leaves the ulnar at the lower end of the fore arm, and passes under the tendon of the flexor ulnaris to the back of the hand. It there meets ramuscules of the radial and interosseous, and conjointly they supply with very small branches the back of the wrist, of the metacarpus, and of the fingers.

5. As the Arcus Sublimis is about beginning, the ulnar artery sends superficial but small branches to the integuments of the palm; and a little farther on, a considerable branch, which dives into the bottom of the palm, through the muscles of the little finger, and joins the ulnar extremity of the arcus profundus: this is the Arteria Cubitalis Manus Profunda, of Haller.

6. The Arcus Sublimis then sends a branch to the ulnar side of the little finger. Afterwards in succession three digital branches are sent off, which, arriving at the interstices between the heads of the respective metacarpal bones, each divides into two branches to supply the sides of the fingers which are opposite to each other; one branch is called Digito-radial, the other Digito-ulnar, according to the side of the finger on which the artery may be placed. In this way the radial side

of the left finger, both sides of the ring finger, both sides of the middle finger, and the ulnar side of the fore finger, are supplied.

Fig. 234.



(1.) A view of the minute divisions of the Arcus Sublimis and its branches.—1. The ulnar artery at the lower portion of the fore arm. 2. Point where it passes in front of the anterior carpal ligament. 3. Point where it reaches the palm of the hand. 4, 5, 6, 7, 8, 9. The digital branches which it gives off in the palm of the hand. 10. Point of anastomosis of its branch No. 8 with the branch from the arcus profundus. 11. The termination of the radial artery in sending a branch to the thumb and fore finger. 12, 12. Digito-radial branches of the arcus sublimis. 13, 13. Digito-ulnar branches of the same. 14, 14. Anastomoses and capillary terminations of these arteries in the pulps of the fingers. 15. The radial artery. 16. Point where it passes to the back and outside of the hand under the extensor tendons of the thumb. 17. Last branch of the radial artery, called radialis indicis. 18. End of the arcus profundus on the ulnar side of the hand. 19, 20. Superficial muscular branches of the radial near the wrist. 21, 22. Superficialis volæ and branches to the ball of the thumb.

(2.) The minute divisions of the Arcus Profundus and its branches.—1. Point where the radial comes into the palm of the hand. 2. Anastomosing branch to give off. 3. A branch on the side of the thumb. 4. A branch to the fore finger. 5. Anastomosis of the arcus profundus and a digital branch of the ulnar. 6. The magna pollicis artery. 7, 8, 9, 10, 11, 12. A succession of interosseous branches which anastomose with the digital branches of the ulnar before their bifurcations to each finger. The anastomoses are in arches. The flexor tendons are removed in this piece by being cut off.

The digital arteries, before they divide, receive each a small branch from the arcus profundus. The digito-radial and the digito-ulnar arteries pass along the sides of the fingers in front to their extremities; at the joints and extremities, many anastomoses between the arteries of the two sides of the same finger occur.

The arcus sublimis terminates on the radial side of the palm by a branch which joins the inner branch of the Arteria Magna Pollicis of the Radial.

The most frequent distribution of the arteries of the hand is what has just been described: anatomists are, however, not all agreed on this point. It would probably be more just to say that this occurs more frequently than any other single arrangement. The varieties, in

fact, are so great that, before a hand is opened, it is not possible to know in what manner its arteries will be distributed. Sometimes the Radial Artery furnishes one-half of the arcus sublimis, and the Ulnar the other half. On other occasions, the interosseous artery, or the superficialis volæ, is continued as a large trunk over the ligament of the wrist, to join the arcus sublimis, and to complete the digital arteries.

SECT. IV.—BRANCHES OF THE DESCENDING THORACIC AORTA.

The Aorta, in its course from the lower part of its curvature to the crura of the Diaphragm, gives off several branches to the viscera and to the parietes of the thorax.

The Bronchial Arteries (*arteriæ bronchiales*) are the nutritious vessels of the lungs. There is commonly one for each lung, but sometimes two or more. The right arises frequently from the superior aortic intercostal artery, instead of from the aorta, while the left comes from the latter: occasionally they have a common root.

On either side they follow the course of the bronchus into the substance of the lung, and are distributed along with it, by ramifications which become successively finer and finer, and anastomose with the pulmonary artery, after the manner mentioned in the description of the lungs. Before they enter the latter, they send some small ramifications to the posterior mediastinum, to the pericardium, and to the black bronchial glands.

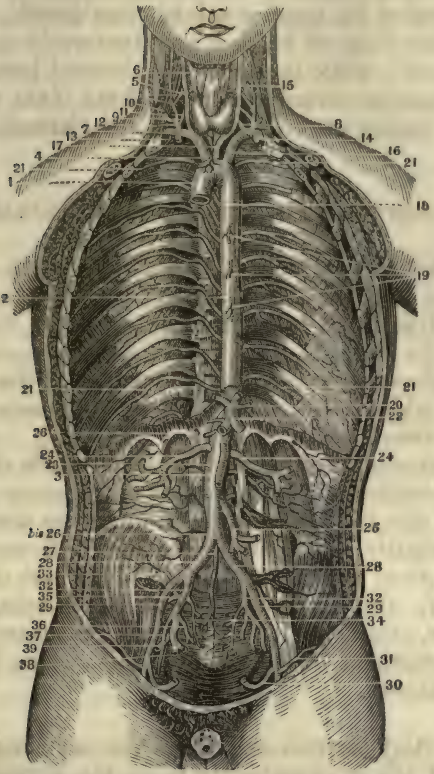
The Œsophageal Arteries (*arteriæ œsophageæ*) are generally five or six small twigs which come successively from the descending thoracic aorta. They ramify minutely in the substance of the œsophagus, communicating freely with each other: the lowest of them also anastomose around the cardia with the superior artery of the stomach.

The Posterior Arteries of the Mediastinum (*arteriæ mediastinales posteriores*) are numerous and small; they come from the anterior face of the aorta, as well as from the branches last mentioned, and are spent upon the posterior mediastinum, and upon its contents.

The Intercostal Arteries (*arteriæ intercostales inferiores, aorticæ*) of the aorta supply the ten lower subcostal spaces on each side, as the two upper ones are supplied by the subclavian artery. There is commonly an intercostal artery arising distinctly from the aorta for each space, but sometimes two of them arise from a common trunk. They increase successively in size from above downwards. Those for the right side having to cross the spine behind the œsophagus and the vena azygos, are, of course, longer than such as belong to the left. The upper ones on either side have to ascend, in order to reach their destination.

Each artery joins the rib near its tubercle, and goes along the groove in its lower margin, between the external and the internal intercostal muscle, for two-thirds of the length of the rib. It then abandons the groove, and divides into several branches, which go to the intercostal

Fig. 235.



The Aorta in its whole length.—1. Arch of the aorta. 2. Descending thoracic aorta. 3. Abdominal aorta. 4. Arteria innominata. 5. Right primitive carotid. 6. Superior thyroid. 7. Right subclavian. 8. Vertebral. 9. Inferior thyroid. 10. Anterior cervical. 11. Transverse cervical. 12. Superior scapular. 13. Superior intercostal. 14. Section of internal mammary. 15. Left primitive carotid. 16. Left subclavian. 17. Root of left primitive carotid. 18. Some of the upper intercostal arteries. 19. Œsophageal arteries. 20. Phrenic arteries, here coming off from the cœliac. 21. An intercostal artery 22. Tripod of Haller, or division of the cœliac into hepatic, gastric, and splenic arteries. 23. Superior mesenteric, cut off. 24. Emulgent artery. 25. Inferior mesenteric. 26. Ligamentum arcuatum. *bis* 26. Lower end of aorta. 27. Middle sacral—last branch of the aorta. 28 Primitive iliacs. 29. External iliacs. 30. Epigastric artery. 31. Circumflex iliac. 32. Internal iliac artery. 33. Ileo-lumbar. 34. Lateral sacral. 35. Gluteal. 36. Vesical artery. 37. Obturator. 38. Ischiatic. 39. Internal pudic, cut off.

muscles and contiguous parts, and anastomose in front with the internal mammary artery.

As each intercostal artery passes the head of the rib, it sends a branch backwards (*ramus dorsalis*), between the transverse processes of the adjoining vertebræ, which penetrates to the posterior face of the trunk, and is distributed to the muscles and skin on the side of the spine. A ramification from this branch enters the intervertebral foramen, and is spent upon the medulla spinalis and its membranes.

Each intercostal artery also gives off, about the middle of the rib, a branch (*ramus costalis inferior*), much smaller than the trunk. This branch advances along the upper margin of the rib below, and gives ramifications to its periosteum and to the adjacent intercostal muscles.

The last intercostal artery is remarkable for its size. Its origin is concealed by the small muscle of the diaphragm, to which it gives some

ramifications: it then passes, at the under margin of the last rib, behind the upper end of the quadratus lumborum muscle, where it divides into three branches; one of which goes transversely to the broad muscles of the abdomen; while the other two descend between the oblique and transverse muscles towards the crest of the ilium, where they anastomose with the lumbar arteries, and with the circumflexa ilii.

SECT. V.—OF THE BRANCHES OF THE ABDOMINAL AORTA.

The Phrenic Arteries (*arteriæ phrenicæ*) are two in number, one for the right and the other for the left side of the diaphragm. They arise singly, but sometimes by a common trunk, from the front of the aorta, immediately on the latter showing itself in the abdomen, between the crura of the diaphragm; consequently, just below the crossing of the muscular fibres, which takes place between the foramen for the aorta and that for the œsophagus.

The phrenic arteries ascend along the lesser muscle of the diaphragm, and give some ramifications to it and to the capsulæ renales. They then divide each into two leading trunks, which are distributed over the diaphragm, principally on its concave surface. Some small ramifications from them go to the liver and to the lower part of the œsophagus.

The two phrenic arteries anastomose with each other: also, with the superior phrenics, coming from the internal mammary; and with the intercostals. Sometimes one or both of them come from the cœliac artery, or its branches.

The Cœliac Artery (*arteria cœliaca*) is the next branch of the abdominal aorta, and arises immediately below the phrenics, between the crura of the diaphragm, opposite the junction of the last dorsal with the first lumbar vertebræ. It is a very large trunk, and goes off at right angles, being placed between the left lobe of the liver and the superior margin of the pancreas. When it is only half an inch long, it is split into three trunks, the Gastric, the Hepatic, and the Splenic; this division is the Tripus Halleri.

The Gastric Artery (*arteria gastrica coronaria ventriculi*) is the smallest of the three trunks, and frequently arises from one of the others. It advances forwards and towards the cardiac orifice in order to reach the small curvature of the stomach, the course of which it pursues to the pylorus, between the two laminæ of the smaller omentum. It gives off the following branches:—

a. Ramifications to the œsophagus, some of which ascend along it into the posterior mediastinum, and anastomose there with the similar branches coming from the aorta; others go transversely, so as to surround the cardia, reach the greater end of the stomach, and anastomose with the vasa brevia.

b. The ramifications to the stomach are abundant, but of an indeterminate number, and arising along its lesser curvature, are distributed in winding branches to the anterior and the posterior surfaces of this viscus, between its membranes.

c. Not unfrequently the artery which supplies the left lobe of the liver is a branch from the gastric, in which case the latter is much larger than usual.

2. The Hepatic Artery (*arteria hepatica*) is generally considerably larger than the gastric, and inclines towards the right side, in order to reach the liver, which it does through the capsule of Glisson. It sends off the following branches:—

a. The Right Gastric or Gastro-Epiploic Artery (*arteria gastrica dextra*) comes from it near the pylorus, and descending between the duodenum and pancreas, reaches the greater curvature of the stomach, to the right half of which, and to the corresponding part of the great omentum, it is distributed. In the early part of its course, the right gastric detaches some small ramifications to the pylorus (*arteria pyloricæ*); also, to the duodenum and to the pancreas (*art. pancreatico-duodenales*). The latter communicate, by very free anastomoses, with the superior mesenteric artery.

After having sent off this branch, the hepatic artery advances to the transverse fissure of the liver, in front of and to the left of the vena portarum. It then divides into a right and a left branch. The former sends off a ramification to the gall-bladder (*art. cystica*), which first reaches its neck, and is distributed, by many arterioles, upon the parietes of this reservoir; the right branch then penetrates deeply into the transverse fissure, and is distributed by many ramifications, throughout the right lobe of the liver. The left branch of the hepatic artery is distributed, in the same manner, throughout the left lobe of the liver.

3. The Splenic Artery (*arteria splenica*) is larger in the adult than either of the other two branches of the cœliac, and goes to the spleen along the superior margin of the pancreas, performing, in this course, several considerable flexuosities. It gives off the following branches:—

a. The Pancreatic Arteries (*art. pancreaticæ mediæ et sinistræ*) come successively from its inferior margin, as it goes along the pancreas. Their number and size are variable, but commonly they are not bigger than a knitting needle; they penetrate perpendicularly into the pancreas, and then subdivide minutely in furnishing its structure.

b. The left Gastric Artery (*art. gastrica sinistra, gastro-epiploica sinistra*) comes from the left extremity of the splenic, and is about the same size with the right gastric artery, but sometimes larger. It attaches itself to the left extremity of the stomach, and goes along the left half of its greater curvature, terminating by an anastomosis with the right gastric artery. In this course, it detaches ramifications to the front and to the back of the stomach, and to the omentum majus.

c. The Short Vessels (*vasa brevia, art. gastricæ breves*) come from the splenic, immediately before it enters the spleen, and after it has subdivided for that purpose. They are five or six in number, and are distributed upon the greater extremity of the stomach, between the cardia and the left gastric artery. The anastomoses between the

several arteries of the stomach are so free that a fine injection pushed into one, readily finds its way into all the others.

The splenic artery, when it gets to the left end of the pancreas, is divided into a cluster of branches, and in that condition enters the fissure of the spleen, throughout the interior of which it is divided into innumerable ramifications.

The Superior Mesenteric Artery (*arteria mesenterica superior*) arises from the aorta, while the latter is still engaged, between the crura of the diaphragm. It is about the same size as the cœliac, and comes off half an inch below it. It is distributed to all the small intestines and to the right side of the large one after the following manner: it first passes behind the pancreas, and then in front of the duodenum, to reach the root of the mesentery, between the two laminæ of which it divides and subdivides into several series of arches, one after another: they become successively smaller and more numerous till they reach the margin of the intestine, where they cease by sending a great many small parallel branches.

The trunk of the superior mesenteric artery, in descending between the lamina of the mesentery, describes a considerable curvature, the convexity of which is to the left side and downwards, while its concavity is in a contrary direction. It is from the convexity of this trunk that from fifteen to twenty large branches are sent off successively to form the roots of the first row of arterial arches. These branches are shorter, and generally somewhat smaller, the lower down they arise, and their origins very closely succeed each other. Upon the first row of arches or anastomoses is formed a second more numerous and small, and upon the second row is formed a third still more numerous and small, from which proceed the intestinal branches.

Besides the preceding branches, the superior mesenteric artery sends off the following:—

Near its root several small ramifications arise which go to the duodenum and to the pancreas, and anastomose there with the other arteries supplying the same organs.

From about the middle of the concavity of the superior mesenteric artery, arise the three Colic arteries called Ileo-colica, Colica Dextra, and Colica Media Dextra: the first supplies a cluster of branches to the lower part of the ileum and to the head of the colon, anastomosing on the left with the last of the small intestinal arteries and on the right with the colica dextra: the Colica Dextra is smaller than either of the other two branches, and going between the laminæ of the mesocolon, supplies the ascending portion of the colon by dividing into two principal branches, one of which anastomoses with the ileo-colic artery, and the other with the colica media: the Colica Media, situated between the laminæ of the transverse mesocolon, and arising higher up than the colica dextra, advances forwards, and divides into two principal trunks; one of which supplies that part of the colon in the right hypochondriac region, and the other the remainder of its transverse portion, forming an anastomosis with the colica superior of the inferior mesenteric artery.

The Capsular Arteries, the Emulgents, and the Spermatics, arise from the aorta, between the superior and the inferior mesenteric. But they will be described after the inferior mesenteric, so as to keep together the account of the arteries of the intestines.

The Inferior Mesenteric Artery (*art. mesenterica inferior*) generally arises about one inch above the division of the aorta into the two primitive iliacs, and is much smaller than the superior Mesenteric. It inclines downwards to the left side, and gets between the laminæ of the mesocolon; it then divides into three branches, called the Left Colic Arteries, from their distribution to the left side of the colon. From their relative situation to each other, they are distinguished into the Superior, the Middle, and the Inferior; sometimes, however, there are but two of these trunks.

The Superior Colic (*art. colica sinistra superior*) goes horizontally towards the colon in the left lumbar region; having got near the intestine, it divides into two branches, one of which ascends to the transverse colon to form the anastomosis with the Colica Media dextra of the upper mesenteric, while the other descends to unite with the colica media sinistra. The Middle Colic Artery (*art. colica media sinistra*) is sometimes a branch of the superior, and is occasionally wanting; it goes towards the upper part of the sigmoid flexure of the colon, and then bifurcates: one branch ascends to form by anastomosis an arch with the superior colic, while the other branch descends to join the lower colic artery. The Inferior Colic Artery (*art. colica inferior sinistra*) goes towards the middle of the sigmoid flexure of the colon, and there, like the preceding, divides into two branches; one anastomoses with the artery above, while the other joins with the arteries which go to the rectum from the inferior mesenteric.

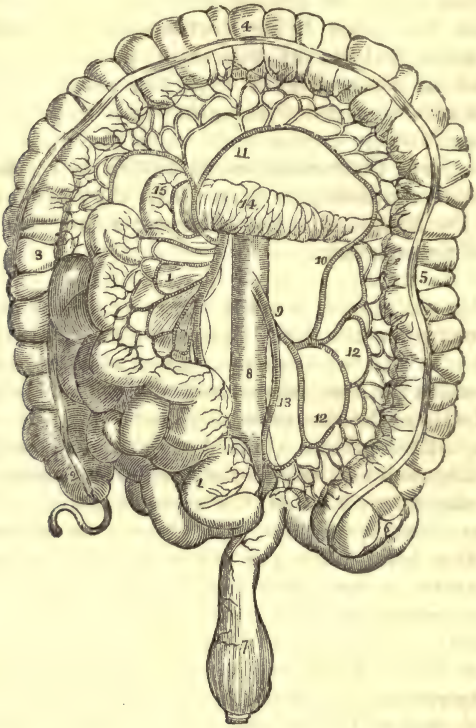
The arteries which supply the colon, both from the upper and lower mesenteric, differ from those supplying the small intestines, in forming but one regular row of arches; which, in fact, are produced by the anastomoses spoken of, and have, therefore, extremely large meshes. From the convexity of these arches, many parallel branches run out to supply the colon, and are very minutely distributed to it. Second and third anastomoses are rare.

The Superior Hemorrhoidal Artery (*art. hæmorrhoidea superior, interna*) is the lowest and the last branch of the inferior mesenteric. It descends between the laminæ of the mesorectum, and is resolved into two symmetrical trunks, which radiate by dividing and subdividing on the side of the rectum, and are dispersed in very fine and numerous branches throughout its substance. It anastomoses with the middle and the inferior hemorrhoidal arteries, also with the lateral sacral.

The Capsular Arteries (*art. capsulares*) arise frequently from the aorta just below the superior mesenteric; but quite as often, if not more so, from the emulgents. They are not larger than a crow's quill, and vary from one to three on either side; generally, however, not exceeding one, and when they do, they are proportionably small. Passing horizontally outwards, they divide into several small ramifica-

tions, which terminate in the capsulæ renales. Some of their branches go to the lesser muscle of the diaphragm.

Fig. 236.



The Distribution of the Mesenteric Arteries.—1. Superior mesenteric, with its branches to the small intestines turned back. 2. The cæcum. 3. Ascending colon. 4. Transverse colon. 5. Descending colon. 6. Sigmoid flexure. 7. The rectum. 8. The aorta. 9. The inferior mesenteric artery. 10. Colica sinistra superior. 11. Colica media dextra anastomosing with the latter. 12. Colica sinistra media and inferior. 13. Superior hemorrhoidal. 14. The pancreas. 15. Descending portion of the duodenum.[1]

The Emulgent Arteries (*art. emulgentes, renales*) are two in number, one for each kidney, but sometimes more. They are large, but short; arise from the side of the aorta immediately below the superior mesenteric, and pass outwardly in a horizontal direction. The right one is longer than the left, somewhat lower down, and passes behind the ascending cava. They are both, in their course from the aorta to the kidney, covered in front by the emulgent vein, and have to pass through a mass of adipose matter.

The emulgent sends off some fine ramifications to the adipose matter, which surrounds it, and before it reaches the fissure of the kidney divides into three or four branches, preparatory to its introduction into this gland, upon the structure of which it is ultimately distributed by very fine branches.

[1] The artist has introduced here a second and third series of anastomoses in great numbers for the inferior mesenteric, which is a very unusual state of things. The text represents properly the rule.

The Spermatic Arteries (*arteriæ spermaticæ*, *seminales*) arise from the aorta somewhat below the emulgents, but in some cases from the latter themselves. They are two in number, one on each side, and are about the size of a crow's quill in the male subject, but smaller in the female. One comes off generally higher up than the other; they then descend on the sides of the vertebral column before the psoæ muscles, and cross in front of the ureters, being in all this course behind the peritoneum. They are tortuous, and shortly after their origin begin to adhere to the spermatic veins, which adhesion is continued to the testicle.

The branches that the spermatic artery sends off in the abdomen are inconsiderable, consisting in very fine twigs to the adjacent adipose matter, to the lymphatic glands, to the ureter, and to the peritoneum. In the male subject it passes with the vas deferens, through the abdominal canal, and reaching the testicle divides into branches which supply the body of this gland and the epididymis. In descending from the external ring to the testis, some small ramifications, to the adjacent parts, leave it. In the female, the spermatic artery does not leave the cavity of the abdomen, but, descending into the pelvis, gets between the laminæ of the broad ligament to the ovarium, and is spent principally upon the latter. Some of its branches go to the Fallopian Tube, to the Round Ligament of the uterus, and to the sides of the latter, where they anastomose with the uterine arteries.[1]

The Lumbar Arteries (*arteriæ lumbares*) are commonly five in number on either side, but seldom less than three, and in their course outwards correspond with the intercostal arteries. They are much larger than the latter. They arise in pairs from the posterior external face of the aorta, at a point corresponding with the middle of the bodies of the four upper lumbar vertebræ, and pass outwards between the fasciculi of the psoas magnus muscle, to which, to the quadratus lumborum, and the bodies of the vertebræ, they distribute several branches. Sometimes each pair arises by a common trunk from the posterior face of the aorta. As the latter terminates at the fourth lumbar vertebra, the fifth lumbar artery is a branch from the fourth, in most instances.

At the base of the transverse process each artery divides into two branches, a posterior or dorsal one, and an anterior or lumbar. The dorsal branch, which is smaller than the other, detaches a ramification through the intervertebral foramen to the lower part of the medulla spinalis and to the cauda equina: it then gets to the back, where it is spent upon the muscles near the spine. The anterior lumbar branch advances between the broad muscles of the abdomen to which it is distributed, and runs forwards far enough to anastomose with the epigastric artery.

The first lumbar artery is the smaller, and sometimes comes from the last intercostal: it goes a little below the inferior margin of the last rib, and then descends almost vertically between the peritoneum and the transversalis abdominis muscle. The lower lumbar arteries anastomose with the circumflexa ilii, and with the superficial branches of the gluteal.

[1] The spermatic artery is spindle-shaped, the smallest end being the origin; this favors the flow of blood in it, which would otherwise suffer from so much friction.

The Middle Sacral Artery (*arteria sacra media*) is generally not so large as a lumbar; it arises from the centre of the bifurcation of the aorta into the two primitive iliacs, or else a line or two above it, behind. It descends, in front of the middle line of the fifth lumbar vertebra and of the sacrum, to the coccyx, adhering to the surface of these bones, and performing some flexuosities.

It sometimes happens that the last pair of lumbar arteries comes from it, or at least one, according to Meckel, more commonly the left: in which case the sacral is of unusual size. The sacral afterwards sends off, to the right and left, a pair of branches for each pair of sacral foramina. They run across the sacrum, send branches to it, anastomose with the lateral sacral arteries, and then penetrate to the cauda equina. The middle sacral artery is lost at the inferior end of the coccyx, in the fat and cellular tissue of the part.

SECT. VI.—OF THE PRIMITIVE ILIAC ARTERIES, AND THEIR BRANCHES.

The Primitive Iliac Arteries (*art. iliacæ primitivæ, communes*), one on each side, are, as mentioned, the terminating trunks of the abdominal aorta. They extend from the lower part of the fourth lumbar vertebra to near the sacro-iliac junction (that is, about an inch from it), where they divide into two trunks, the Internal and the External Iliac. This division, however, not unfrequently occurs at the inferior lateral edge of the fifth lumbar vertebra, near the base of the sacrum.

The primitive iliac is bounded on the outer side by the psoas magnus muscle, and behind by the primitive iliac vein; when of full length, it is crossed at its lower part by the ureter. No branches deserving of especial notice are sent from it before it bifurcates; such as exist are very small, and go simply to the parts immediately contiguous. The right artery crosses in front of the root of the left iliac vein.

SECT. VII.—OF THE INTERNAL ILIAC, OR THE HYPOGASTRIC ARTERY.

The Internal Iliac Artery (*art. iliaca-interna, hypogastrica*) descends from its origin near the front upper part of the sacro-iliac junction, to the lower part of the same articulation. In this descent, it is bounded behind by the sacral plexus of nerves, and gives off several arterial trunks: but the manner by which the last is accomplished is much varied in different subjects. For the most part, it is an inch or more long before any important branches leave it; it is then frequently divided into two principal trunks, an anterior and a posterior, from which proceed the several branches that supply the internal and the external parts of the pelvis. The rule of origin of the secondary trunks from these two principal ones, even when the latter exist, is not fixed; for sometimes they arise from one, sometimes from the other, and then again from the trunk of the hypogastric itself.

The Ilio-Lumbar Artery (*art. ilio-lumbaris*) is commonly the first branch of the hypogastric, or of its posterior trunk. It ascends out-

wards and backwards behind the psoas magnus muscle, and there divides into two branches, a superior and an inferior. The former continues to ascend between the psoas magnus and the iliacus internus muscle, to which, and to the quadratus lumborum, it distributes branches: it also sends ramifications into the spinal cavity, and anastomoses with the lower lumbar arteries; sometimes it supplies the place of the last lumbar entirely. The inferior branch going outwardly, is divided into two orders of ramifications which supply the iliacus internus muscle, on its surface and more deeply; also the os ilium by a ramuscule which penetrates the nutritious foramen of the latter. The inferior branch anastomoses with the circumflexa ilii of the external iliac.

Fig. 237.

The Arteries of the Pelvis and Thigh, as seen from the inner side, by a vertical section.—1. Inferior extremity of the abdominal aorta, just where it divides into the iliac arteries. 2. Right primitive iliac. 3. Right external iliac. 4. Origin of epigastric artery. 5. Circumflex iliac. 6. Hypogastric or internal iliac artery. 7. Ilio-lumbar. 8. Gluteal. 9. Obturator. 10. Lateral sacral. 11. Vesical arteries cut off. 12. Middle hemorrhoidal. 13. Internal pudic. 14. Ischiatic. 15. Femoral artery at the crural arch. 16. Point where it passes through the adductor magnus. 17, 20, 21. Profunda. 18. Internal circumflex. 19, 19, 19. Perforating arteries. 22, 24. Small muscular arteries. 23. Femoral, seen in the adductor magnus. 25. The anastomotica of the femoral. 26. Popliteal artery. 27. The same artery behind the knee joint under the soleus muscle 28. A supernumerary articular artery. 29. Superior internal articular artery. 30. Inferior internal articular artery. 31. Anastomosis of these with anastomotica.

The Lateral Sacral Arteries (*arteriæ sacræ laterales*) arise next, either from the hypogastric or from its posterior trunk: their number is commonly equal to that of the foramina on the side of the sacrum in front, though they may come from only one or two roots. They cross in front of the sacrum, and divide into branches, some of which anastomose with the middle sacral artery, while others enter the foramina of the sacrum, to be spent on the lower part of the cauda equina.

The Obturator Artery (*arteria obturatoria*) comes commonly from the hypogastric or from one of its principal trunks; in some cases, it arises from the epigastric or from the external iliac, near Poupart's ligament. In the first cases, it passes forwards parallel with the brim of the pelvis, and in the latter it descends behind the superior ramus of the pubes. Whatever may be the condition of its origin, it gets from the pelvis through the upper part of the thyroid foramen over the superior margin of the obturator internus muscle, having previously sent off some inconsiderable ramifications to the periosteum and the contiguous muscles within the pelvis.

It emerges from the pelvis on the upper margin of the obturator externus muscle, and then divides into two principal trunks. The posterior descends along the external margin of the obturator externus muscle, to which it gives ramifications; it likewise sends some branches to the heads of the muscles coming from the tuber of the ischium, and thereby anastomoses with the sciatic artery; other branches are spent upon the hip joint, one of which gets into the cavity of the latter through the notch at the lower part of the acetabulum, and is spent upon the adipose matter in its bottom. The anterior branch goes to the heads of the adductor muscles, to the pectineus, to the obturator externus, and to the integuments of the upper internal part of the thigh. Near its origin this branch sends a ramification along the internal margin of the thyroid foramen to anastomose with the posterior branch, so that the foramen is surrounded by an arterial circle.

The Middle Hemorrhoidal Artery (*art. hæmorrhoidea media*) varies in its origin, being sometimes from the hypogastric itself and, on other occasions, from one of its branches, as the gluteal, ischiatic, &c. It descends on the fore part of the rectum, opposite the lower fundus of the bladder in the male, and is distributed by branches to the rectum, to the vesiculæ seminales, and to the prostate gland. In the female it dispenses branches to the vagina. It is called middle, from its position between the upper and the lower hemorrhoidal artery.

In both sexes, the branches which it sends to other parts besides the rectum frequently arise from other arteries, and in a manner which causes them to have distinct appellations, as vaginal, &c.

The Vesical Arteries (*arteriæ vesicales*) consist in several ramifications, coming from what was the umbilical artery of the fœtus, but which, in the adult, with the exception of a short space near its origin, is converted into a ligamentous chord. These branches ramify upon the parietes of the bladder; one of them, more voluminous than any other, and called, by M. Chaussier, vesico-prostatic, gains the lower

fundus of the bladder; sends branches to it, to the prostate, to the vesiculæ seminales, and to the commencement of the urethra.

The Uterine Artery (*arteria uterina*) arises from the hypogastric, or one of its branches, near the vesical, sometimes before, and on other occasions subsequent to them. Being peculiar to the female sex, its size varies according to the individual being in a state of pregnancy or not: in the latter stages of gestation, it is as large as any other branch of the hypogastric.

It goes inwards towards the superior part of the vagina, to which it gives some ramifications; it then ascends between the laminæ of the broad ligament, in a tortuous manner along the side of the uterus, and divides into many branches which are distributed through the tissue of this organ. It anastomoses with the corresponding arteries of the other side, and with the branches of the spermatic artery which go to the Fallopian tube and to the ovarium.

Besides the preceding, the Hypogastric or Internal Iliac artery sends off two large branches, the Gluteal and the Ischiatic, which terminate it. In many subjects they are the direct continuation of the two primitive trunks, into which the hypogastric is frequently originally divided.

The Glutéal Artery (*arteria glutea*), shortly after its origin, issues from the pelvis above the pyriformis muscle, at the upper part of the ischiatic foramen, where it adheres closely to the edge of the bone. When it first gets to the dorsum of the ilium, it is covered by the gluteus magnus muscle, and lies at the posterior margin of the gluteus minimus, precisely under a line drawn from the posterior superior spinous process to the top of the trochanter major. It almost immediately afterwards divides into two principal trunks.

One of these trunks, the more superficial, advances between the gluteus medius and the magnus, and distributes branches to them; also, to the posterior margin of the magnus, where it comes from the posterior sacro-sciatic ligament. The more deeply-seated trunk goes forwards between the gluteus medius and minimus, and subdivides into three orders of branches for their supply. One set follows the superior margin of the gluteus minimus towards the anterior superior spinous process; another set passes nearer the middle of the gluteus minimus, and the third set still lower down upon the dorsum of the ilium, above the acetabulum; some of the ramifications go to the capsular ligament of the joint, where they anastomose with branches from the femoral artery.

The Ischiatic Artery (*arteria ischiadica*) is somewhat smaller than the gluteal, but looks rather more like the continuation of the hypogastric. It descends between the rectum and the pyriformis muscle, and issues under the lower margin of the latter, out of the pelvis, being there placed in front of the sciatic nerve. It goes downwards on the back of the thigh, between the trochanter major and the tuberosity of the ischium, being at the internal edge of the sciatic nerve, and on the

posterior face of the small rotator muscles of the thigh. It sends off in the pelvis the Internal Pudic Artery, and also some inconstant branches, of small size, to the viscera within the pelvis; when it has emerged from the latter, it detaches some considerable branches to the origin and to the inferior margin of the gluteus magnus muscle, and to the small rotator muscles. The branch which may be considered as the continued trunk of the ischiatic, descending on the posterior face of the thigh, along with the sciatic nerve, under the hamstring muscles, is lost in ramifications to them, and by anastomoses with the perforating arteries.

The Internal Pudic Artery (*arteria pudica interna*), though a branch of the ischiatic, is only in a slight degree smaller. It arises a little above the spinous process of the ischium, in the pelvis, in front of the sciatic plexus, and getting from the pelvis between the anterior sacro-sciatic ligament and the inferior margin of the pyriformis muscle, it passes over the posterior face of the anterior sacro-sciatic ligament, at the spinous process of the ischium. It immediately afterwards returns into the cavity of the pelvis, between the two sacro-sciatic ligaments, at the place where the obturator internus muscle winds over the ischium; it then goes along the internal face of the latter bone and of its ascending ramus, at the inferior margin of the obturator internus muscle, and continues on the internal face of the ramus of the pubes, between the two laminæ of the triangular ligament, above the crus of the penis to the symphysis of the pubes.

In this course the Internal Pudic Artery detaches several important branches, in the following order:—

a. A ramification along the inferior margin of the pyriformis, to this muscle and to the parts on the posterior face of the neck of the os femoris, where it anastomoses with the other arteries of this region.

b. The Lower Hemorrhoidal Artery (*art. hæmorrhoidea inferior, externa*) to the inferior part of the rectum, and to the external sphincter ani muscle. This artery arises after the internal pudic has returned within the pelvis, and consists sometimes in several branches.

c. The Perineal Artery (*art. perinea, transversa perinei*) has its root near the origin of the transversus perinei muscle, and advancing obliquely forwards is distributed in several ramifications to the muscles and teguments of the perineum, and to the posterior part of the scrotum. It is unavoidably cut in the lateral operation for the stone. In the female it goes to the sphincter vaginæ and to the labium externum.

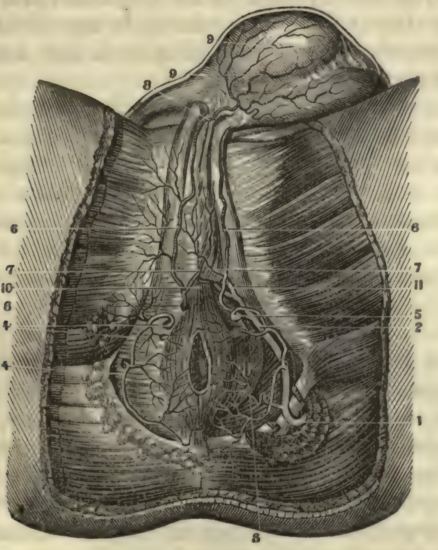
d. When the internal pudic has got beyond the transversus perinei muscle near the beginning of the crus penis, it detaches to the bulb of the urethra, along the posterior margin of the triangular ligament, a branch which penetrates to the corpus spongiosum, and is minutely distributed upon it, some of its ramifications reaching to the corpus cavernosum. This branch is called by M. Chaussier, Urethro-bulbar, and instead of being always distinct, it on some occasions comes from the Perineal.

e. At the under part of the symphysis pubis, between it and the back of the penis, the internal pudic sends forwards, on the dorsum of the penis, a superficial branch (*ramus superficialis dorsi penis*). It advances to the end of the penis, under the skin, being parallel with

its fellow of the other side, and near to it: sometimes the two unite after a short course. They are dispersed in branches to the integuments, to the elastic ligament or capsule of the corpus cavernosum of the penis, and to the glans penis.

f. The Cavernous Artery of the Penis (*art. cavernosa profunda penis*) may be considered as the terminating trunk of the internal pudic. It penetrates the corpus cavernosum, beneath the symphysis of the pubes, and quickly divides into many ramifications. The latter advance, and continue to subdivide upon the cells of the corpus cavernosum, to which they are principally distributed; some of them reach the corpus spongiosum urethræ, and others anastomose with the corresponding arteries of the other side.

Fig. 238.



The Arteries in the Perineum of the Male. On the right side they are seen directly under the fascia, but on the left side are under the muscles.—1. Internal pudic artery between the two sacro-sciatic ligaments. 2. The same artery between the transversus perinei and erector penis muscles. 3. Inferior hemorrhoidal artery. 4. Superficial arteries to the fat around the anus. 5. The perineal artery. 6, 6. Urethro-bulbar artery. 7, 7. Branches of the same to the corpus spongiosum. 8, 9. Branches to the scrotum and dartos. 10. Point of sphincter ani near which is seen the arteria cavernosa of left side. 11. Ramus superficialis dorsi penis.

SECT. VIII.—OF THE EXTERNAL ILIAC ARTERY, AND ITS BRANCHES.

The External Iliac Artery (*arteria iliaca externa*) extends from the bifurcation of the primitive iliac to Poupart's ligament, where it is continued to the lower extremity under the name of the femoral artery. It looks like the continuation of the primitive iliac, and descends at the superior strait of the pelvis along the internal margin of the psoas magnus muscle. In the early part of its course, it is anterior to the external iliac vein; it then, as it approaches Poupart's ligament, gets to its outer margin. It is covered by the peritoneum in front. Where

it passes beneath Poupart's ligament to the thigh, it is about half way between the anterior superior spinous process of the ilium and the symphysis pubis, having the vein at its pubic margin, and the anterior crural nerve half an inch from its iliac margin. No branches of consequence arise before it reaches the crural arch; it then sends off two, the Epigastric and the Circumflex Iliac Artery.

The Epigastric Artery (*arteria epigastrica*) arises somewhat above the crural arch, at the line where the peritoneum is reflected from the fascia transversalis upon the fascia iliaca. It at first passes horizontally inwards, then rises obliquely upwards and inwards, behind the spermatic chord, at the pubic margin of the internal abdominal ring. Afterwards it reaches the external margin of the rectus abdominis muscle, two or three inches above the pubes: ascending along it for a short distance, it then passes to its posterior face, and continues ascending above the umbilicus; where, being divided into several branches, it terminates by anastomosing with the lower ramifications of the internal mammary artery.

This artery is almost entirely spent upon the anterior parietes of the abdomen, in ramifications, which anastomose with the last intercostals and with the lumbar arteries. One of its small twigs, called the External Spermatic artery, following the course of the spermatic chord, or of the round ligament, is distributed upon the cremaster, the tunica vaginalis, and the scrotum of the male, and upon the mons veneris of the female. In some cases the epigastric gives off the obturator artery as stated.

The Circumflex Iliac Artery (*arteria circumflexa ilii*) is of the same size with the epigastric, and comes from the external iliac, sometimes on a level with it, and on other occasions lower down, even below the crural arch. It ascends outwardly towards the anterior superior spinous process of the ilium, along the posterior margin of the crural arch, and following afterwards the direction of the crista of the ilium, it anastomoses with the corresponding branch of the ilio-lumbar artery.

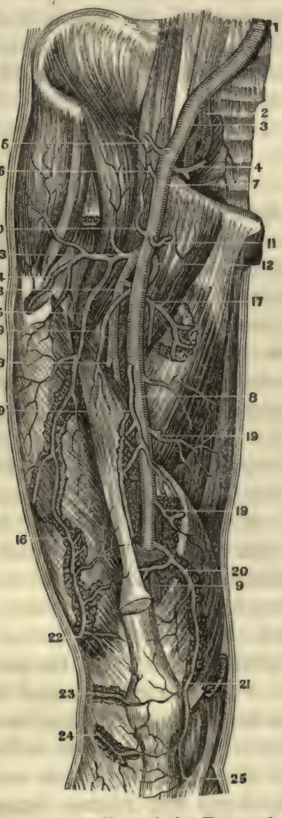
The following branches come from it. In the early part of its course some twigs are sent to the adjacent muscles, as the sartorius, iliacus internus, and so on. At the anterior superior spinous process, it divides into two branches; the smaller ascends between the internal oblique and the transversalis muscle, and is distributed upon them; the other branch which is the continuation of the main trunk along the crista of the ilium at the margin of the iliacus internus muscle, sends ramifications to the latter, and also to the posterior part of the broad muscles of the abdomen, where it anastomoses with the other arteries of this region.

Of the Femoral Artery.

The Femoral Artery (*arteria femoralis, cruralis*), the continuation of the external iliac, extends from the crural arch or Poupart's ligament, to a perforation for its passage through the adductor magnus muscle, and which is commonly one-third of the whole length of the

os femoris, above the knee joint. This great trunk, immediately below Poupart's ligament is very superficial, and may be felt pulsating where it passes over the pubes. It is there covered only by the common integuments, and the fascia femoris, which is thin; it is bounded internally by the femoral vein, externally by the crural nerve; is half way between the anterior superior spinous process and the symphysis of the pubes, and lies upon the internal face of the psoas magnus over the interstice between it and the pectineus. In the upper third of its course the femoral artery is at the inner edge of the rectus femoris, and at a short distance from it; it then inclines inwards, and occupies the angle formed by the adhesion of the vastus internus to the adductor longus. The sartorius, at first, is remote at its outside, but this muscle, inclining inwards in its descent, gets to the exterior margin of the artery, and afterwards covers it completely for the remainder of its course. The femoral artery is in front of the femoral vein when it has

Fig. 239.



A front view of the Femoral Artery, as well as of the External and Primitive Iliacs of the right side.—1. Primitive iliac artery. 2. Internal iliac artery. 3. External iliac artery. 4. Epigastric artery. 5. Circumflex iliac artery. 6. Arteria ad cutem abdominis. 7. Commencement of the femoral just under the crural arch. 8. Point where it is at the inner side of the vastus internus muscle. 9. Popliteal artery. 10. Muscular branch to the psoas and iliacus. 11. External pudic artery cut off. 12. Origin of the internal circumflex. 13. Profunda femoris. 14, 15, 16. Branches of external circumflex. 17. Artery to the pectineus and adductors. 18, 19, 19. Muscular arteries. 20, 21. Anastomotica. 22, 23. Articular arteries. 24. Inferior external articular. 25. Inferior internal articular.

descended three or four inches below the crural arch; behind the two is the arteria profunda. When the femoral artery and vein reach the angle formed by the vastus internus and the adductor longus, they are covered by a strong interlacement of tendinous fibres from these muscles.

The femoral artery sends off these branches:—

1. The Superficial Artery of the Abdomen (*art. ad cutem abdominis*) is small, and arises at the lower margin of Poupart's ligament: it goes upwards towards the umbilicus, beneath the fascia superficialis abdominis, and is distributed to the integuments of this region. One of its ramifications goes to the inguinal glands.

2. The External Pudic Arteries (*art. pudendæ externæ*) come from the femoral at the same point, and are two or three in number; they are of small size. One of them inclines inwards along the groin, between the skin and the fascia femoris, and is distributed to the integuments of the pubes, to those of the penis, and to the scrotum, or to the labium externum of the female. The second, and the third when it exists, are rather lower down, and are dispersed upon much the same region by branches to the integuments. The lymphatic glands of the groin also derive their supply of blood from these several external pudic arteries.

3. The Profound Artery (*arteria profunda femoris*), the great muscular artery of the thigh, is but slightly inferior in size to the femoral itself, and comes from the latter at the distance of from one or two inches below the crural arch. It lies behind the femoral artery, and descends in that situation between the insertion of the adductor brevis and the vastus internus muscle, to the upper part of the insertion of the adductor longus. In this course its size is much diminished by the origin from it of several considerable trunks as follows:—

a. The External Circumflex (*arteria circumflexa externa*), though most frequently a branch of the profunda, sometimes comes from the femoral above or below it a short distance. It goes immediately outwards between the rectus femoris muscle and the cruralis, giving off some inconsiderable ramifications. While between these muscles it divides into two branches, one of which ascends and the other descends; the former is distributed to the anterior margin of the gluteus medius and minimus, to the capsule of the joint, the parts about the trochanter major, and anastomoses with the gluteal and the ischiatic. It is said by Meckel that these anastomoses have been found much dilated where the external iliac artery had been taken up. The descending branch is about the size of a crow's quill, or even larger; it first passes obliquely downwards between the rectus femoris and the cruralis, it then descends vertically under the anterior margin of the vastus externus, between it and the cruralis, to terminate at the knee, where it becomes superficial and anastomoses with the articular arteries. It is, however, principally distributed to the vastus externus and to the cruralis.

b. The Internal Circumflex Artery (*arteria circumflexa interna*) arises from the profunda, near the external circumflex, generally below it, but sometimes the reverse; in some cases, it comes from the femoral artery itself, near the crural arch. It passes transversely inwards, and dips into the interstice between the pectineus and the psoas magnus, after having given off some small twigs to the heads of the adjoining adductors. It then winds under the neck of the os femoris and divides into two branches; the upper one goes to the capsular ligament of the joint, to the obturator externus muscle, anastomoses with the obturator artery, and sends a branch behind the adductor brevis to the upper part of the adductor magnus. The inferior branch is larger than the other, descends behind the adductor magnus, and is distributed in branches to it, to the gracilis, and to the hamstring muscles, sending upwards some ramifications (*rami trochanterici*) to the parts about the trochanter major, where they anastomose with the external circumflex artery.

c. Muscular branches of inconstant origin, and of inconsiderable size, are sent from the profunda to supply the anterior face of the adductor muscles.

d. The Perforating Arteries (*rami profundi perforantes*) obtain the name from their perforating the adductor magnus, which they do near the linea aspera, so as to get to the back of the thigh. They commonly are four in number, and as they come off successively from the profunda, they are designated numerically. In some cases, however, they are reduced to one, by being concentrated in a common trunk, which, penetrating high up the adductor magnus, and afterwards descending on its posterior face, is dispersed upon the muscles on the back of the thigh.

The First Perforating Artery arises somewhat below the trochanter minor, and penetrates the adductor magnus a little below its superior margin. One of its branches ascends towards the trochanter major, where it anastomoses with the external circumflex and with the gluteal, while another descending is spent upon the heads of the flexor muscles of the leg.

The Second Perforating Artery gets to the back of the thigh, at the lower margin of the insertion of the gluteus magnus into the linea aspera, being distributed in that region, and to the corresponding portion of the long head of the biceps flexor cruris.

The Third Perforating Artery penetrates the adductor magnus somewhat below the commencement of the short head of the biceps, and is dispersed upon the adductor and the adjacent portion of the flexor muscles.

The Fourth Perforating Artery penetrates the insertion of the adductor magnus an inch and a half above the opening in it, for the femoral artery; it, in the same way, supplies the posterior face of the adductor and the adjacent muscles.

As a summary, it will be readily understood that the profunda is, in this way (through the external and the internal circumflex, and through the perforating arteries), distributed upon all the large muscles of the thigh.

After the origin of the profunda, the Femoral Artery gives off, at different points of its course to the opening of the adductor magnus, several twigs the size of a large knitting needle; which go to the sartorius, the gracilis, the adductors and the extensors on the front of the thigh; but they are too inconstant to require a more particular description.

The Anastomosing Artery (*arteria anastomotica*) is the last branch of the femoral, and arises just before it perforates the adductor magnus. It descends to the knee, in front of the tendon of the latter, concealed by the internal margin of the vastus internus muscle. It sends off many small twigs to the adjacent muscles, and terminates below by anastomosing with the internal articular arteries. It is about the size of a crow's-quill.[1]

The Popliteal Artery (*arteria poplitæa*) is the continuation of the femoral, after the latter has passed through the tendinous insertion of the adductor magnus, and extends from this point to the opening in the interosseous ligament of the leg, just below the head of the tibia. It, first of all, passes from the internal margin of the os femoris to the notch between the condyles; being there placed in the middle between the internal and the external hamstring muscles, and surrounded by a mass of adipose matter which fills up the hollow of the ham. It is in contact, anteriorly, with the knee joint, and a little below the latter with the popliteus muscle, descending there between the heads of the gastrocnemius. It is covered, in the greater part of its extent, posteriorly, by the popliteal vein, and by the sciatic nerve, the latter being more superficial than the vein.

The popliteal artery sends off some small branches to the hamstring muscles, and to the parts contained between the latter, which are too irregular and inconstant for description.

The following arteries, also, come from it:—

1. The Superior Internal Articular Artery (*art. articularis superior interna*) arises at or above the internal condyle, and frequently consists in two trunks. It passes through the tendon of the adductor magnus, just above the condyle; it then begins to distribute itself in branches, some of which are spent upon the lower part of the vastus internus muscle, and others upon the superior internal part of the knee joint.

2. The Superior External Articulating Artery (*art. articularis superior externa*) arises from the popliteal, somewhat above the external condyle of the os femoris. It winds, horizontally, above the external condyle, around the bone, between it and the lower part of the biceps flexor cruris, and is then distributed also in two orders of branches, some of which supply the lower part of the vastus externus muscle, and others the superior external portion of the knee joint.

3. The Middle Articular Artery (*art. articularis media*) is smaller than either of the above, and sometimes comes from one of them, but

[1] See Fig. 237.

generally from the popliteal, on a line with the articulation of the knee. It is distributed to the posterior part of the capsular ligament, to the crucial ligaments, and to the corresponding adipose matter.

4. The Inferior Internal Articular Artery (*art. articularis inferior interna*) arises on a line with the inferior part of the internal condyle, sometimes lower down. Its origin is very much concealed by the internal head of the gastrocnemius; it passes beneath the latter, and then between the internal lateral ligament of the knee and the head of the tibia; consequently, it is covered by the internal ham-string muscles. It afterwards ascends towards the patella, and is distributed in numerous branches to the inferior internal part of the knee joint, and to the adjacent portion of the tibia.

5. The Inferior External Articular Artery (*art. articularis inferior externa*) arises near the last, below the external condyle, being concealed by the belly of the plantaris. It passes, horizontally, or nearly so, between the popliteus and the outer head of the gastrocnemius, and afterwards beneath the tendon of the biceps and the external lateral ligament of the joint, around the external face of the head of the tibia. It gives small branches to these several parts, and is then distributed, by two orders of ramifications, to the superficial and to the more deeply seated parts at the external inferior portion of the knee joint.

These several articular arteries anastomose freely with each other, and are minutely ramified on the knee joint and the contiguous structure. They also anastomose with the long, descending branch of the external circumflex of the thigh; with the anastomotica of the femoral, and with the tibial recurrent.

6. The Gastrocnemial Arteries (*arteriæ gemellæ*) are two in number, one for each head of the gastrocnemius. They arise commonly between the superior and the inferior articular arteries, and are about the same size. They penetrate into the muscle, and supply it with blood, terminating their course near the lower part of its bellies.

Moreover, some small branches, which go to the contiguous muscles, are frequently observed here; also, the nutritious artery of the tibia; but their number and condition are very inconstant. Near the head of the fibula, branches go from the popliteal artery to the upper end of the soleus muscle.

Generally, on a level with the aperture in the upper part of the interosseous ligament, but sometimes an inch or two higher up, the popliteal artery terminates by dividing into two large trunks, the Anterior and the Posterior Tibial.

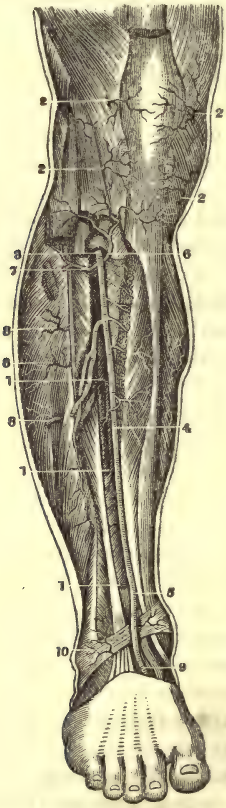
The Anterior Tibial Artery (*art. tibialis anterior*) passes forwards through the foramen of the interosseous ligament just below the head of the fibula, and runs down the front of the leg and foot, as far as the base of the metatarsal bone of the great toe. In this course, its relative situation is as follows:—

It rests upon the front of the interosseous ligament of the leg, on a line drawn from the middle anterior part of the head of the fibula to

the middle of the ankle joint. Superiorly, it is bounded on the tibial side by the tibialis anticus muscle, and on the other, by the extensor longus digitorum: lower down on the leg, the place of the latter is supplied by the extensor pollicis pedis. Somewhat above the ankle joint the artery, leaving the interosseous ligament, rests upon the front of the tibia, and then gets to the top of the foot, between the joint and the annular ligament. Under the ligament it is crossed by the tendon of the extensor pollicis, which gets to its inner side, and afterwards continues so. The anterior tibial nerve adheres to it in its whole length.

The following branches come from the anterior tibial artery:—

Fig. 240.



Anterior Tibial Artery, and its branches.—1, 1. The remains of the extensor proprius pollicis pedis muscle and tendon. 2, 2. Superficial branches from the popliteal artery, known as articular arteries. 3. Anterior tibial artery, as it comes through the interosseous ligament. 4. The same artery, on the middle of the leg. 5. Point where it passes under the extensor proprius tendon and the annular ligament. 6. Recurrent branch. 7. Branch to the extensor communis and peroneus longus muscles. 8. 8. Other muscular branches. 9. Pedal artery, or continuation of the anterior tibial on the foot. 10. External malleolar artery.

1. The Recurrent Tibial (*art. tibialis recurrens*) ascends through the upper extremity of the tibialis anticus muscle, having come off from the anterior tibial immediately upon the latter getting to the front of the leg. Several small ramifications pass from it to the heads of the con-

tiguous muscles on the tibia, and to the lower part of the knee joint, where it anastomoses with the lower articular arteries of the knee.

2. Several small arterial twigs are afterwards sent to the muscles and to the periosteum of the leg, as the anterior tibial descends; but they are too inconstant in size and position to require description.

3. The Internal Malleolar Artery (*art. malleolaris interna*) arises from the anterior tibial, an inch or two above the ankle joint. It descends, inwardly, between the tibia and the tendon of the tibialis anticus, and, having gained the internal malleolus, is distributed by branches upon it and upon the adjacent portion of the articulation.

4. The External Malleolar Artery (*art. malleolaris externa*) consists most commonly in two arterial twigs of small size, but frequently in one only. It arises in front of the ankle joint, and going outwardly between it and the tendons of the extensor digitorum longus, is spent upon the external face of the articulation, where it inosculates with the peroneal artery.

This artery is sometimes of considerable size, in which case it also supplies the outer part of the tarsus, and is a substitute for the next.

5. The Tarsal Artery (*arteria tarsea*) arises from the anterior tibial somewhat below the ankle joint near the scaphoides, and, going outwardly beneath the extensor brevis digitorum muscle, it is distributed in branches near the external ankle, and upon the outer upper surface of the tarsus. It anastomoses with the external malleolar, with the external plantar, and with the metatarsal artery.

Some small branches also pass from the anterior tibial at this point to the upper internal face of the tarsus.

6. The Metatarsal Artery (*art. metatarsea*) arises just below the last. It is directed forwards and outwards beneath the extensor brevis muscle, and forms a sort of arch at the roots of the metatarsal bones. It furnishes several ramifications to the upper surface of the tarsus and the contiguous parts; amongst them is an interosseal artery for each of the three outer interosseal spaces. These arteries communicate, by small anastomoses, with the arteries of the sole of the foot, both at the bases and at the ends of the metatarsal bones, and terminate in front by supplying the backs of the small toes.

This artery is sometimes a branch of the tarsal.

7. The Dorsal Artery of the Great Toe (*art. dorsalis hallicis*) arises from the anterior tibial at the root of the first metatarsal bone. It runs along the superior face of the first metatarsal interval, and, having reached the anterior end of it, divides into two branches, one of which goes to the back of the great toe and the other to the tibial margin of the next toe.

The Anterior Tibial, in its course from the ankle joint to the base of the first metatarsal bone, is sometimes called Pedal (*arteria pediœa*);

at the posterior end of the first metatarsal interval, being still of considerable size, it sinks down to the sole of the foot, and joins itself to the external plantar artery at this point.

It frequently happens that the anterior tibial, being small in its course down the leg, is joined by the continued trunk of the peroneal, which perforates the interosseous ligament somewhat above the ankle joint. Afterwards the trunk formed by this union, being of considerable size, follows the course and has the distribution mentioned.

The Posterior Tibial Artery (*arteria tibialis postica*) is sometimes called, at its commencement, till it gives off the peroneal, tibio-peroneal; it extends from the head of the tibia to the sinuosity of the os calcis, in a line from the middle of the ham to the internal ankle. It is at the tibial side of the back of the leg, on the posterior face of the flexor longus digitorum muscle, and covered by the fascia of the latter. In the two superior thirds of its course, it is concealed behind by the gastrocnemius and the soleus muscle: in the inferior third, it is at the internal margin of the tendo-Achillis. At the ankle joint, before it passes into the sinuosity of the os calcis, it is between the tendon of the tibialis posticus and that of the flexor longus pollicis pedis, being covered by the laciniated ligament. It is accompanied, at its external margin, by the posterior tibial nerve.

The posterior tibial artery is distributed after the following manner:—

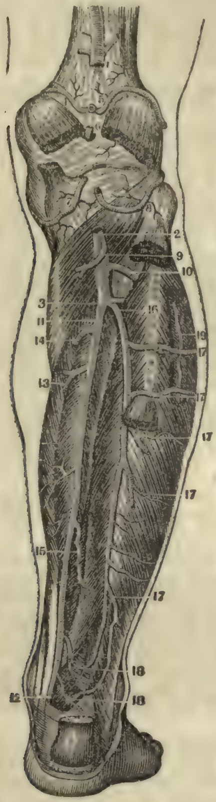
1. The Peroneal Artery (*arteria peronea*) is its first branch of any importance, and is but little smaller than the continued trunk. It arises an inch or two below the origin of the anterior tibial, and extends, on the posterior face of the leg, to the external ankle. It is, in some measure, concealed by the posterior side of the fibula, being placed there between the origin of the flexor longus pollicis muscle and the external edge of the tibialis posticus. It is covered behind by the flexor longus pollicis, by the soleus, and by the gastrocnemius; it is, therefore, deep and of extremely difficult access in the living body.

In this course, it sends small branches to the gastrocnemius, to the soleus, and to the other contiguous muscles on the back of the leg. After having descended two-thirds of the length of the fibula, it divides into an anterior and a posterior branch. The former traverses the interosseous ligament, and descending in front of it, covered by the muscles which arise from the lower part of the fibula, is distributed upon the upper external part of the foot near the ankle joint. The posterior branch continues in the primitive course of the peroneal artery at the internal posterior margin of the fibula, and descending behind the tibio-peroneal articulation, reaches the external face of the os calcis: it detaches several small ramifications to the contiguous muscles, and, upon the os calcis, is divided into twigs which supply the adjacent parts and the integuments below the external ankle.

2. In the descent of the posterior tibial artery to the hollow of the os calcis, it detaches several small muscular branches, principally to the tibialis posticus, and to the flexors of the toes. One twig, which is the nutritious artery of the tibia, comes from its upper part when

not furnished from the popliteal artery, and enters the foramen on the posterior surface of the bone.

Fig. 241.



A view of the Arteries on the Back of the Leg. The Gastrocnemius and Soleus Muscles have been removed so as to display the vessels in their whole length.—1. The popliteal artery, cut off so as to show the articular arteries. 2. Lower end of the same artery on the popliteus muscle. 3. Point of bifurcation into the posterior tibial and peroneal. 4. Superior internal articular artery. 5. Superior external articular artery. 6. Middle articular artery. 7. Inferior internal articular artery. 8. Inferior external articular artery. 9. Branch to the head of the soleus muscle. 10. Origin of the anterior tibial artery. 11. Origin of the posterior tibial artery. 12. Point where it passes behind the internal ankle to become the plantar. 13, 14, 15. Muscular branches. 16. Origin of the peroneal artery. 17, 17. Small muscular branches. 18, 18. Anastomosis of the posterior tibial and peroneal arteries near the heel. 19. Muscular branch from the anterior tibial.

While the posterior tibial is in the hollow of the os calcis, between it and the abductor muscle of the great toe, it furnishes some small twigs to the contiguous muscles, and to the integuments of the sole of the foot; it then divides into two branches, the Internal and the External Plantar Artery.

The Internal Plantar Artery (*art. plantaris interna*) is much smaller than the other. It advances between the abductor pollicis pedis and the internal inferior margin of the bones of the foot, and terminates at the anterior end of the first metatarsal bone, by joining the internal digital artery of the great toe. In this course, it sends, continually,

small ramifications to the muscles of the great toe and to the flexor brevis digitorum pedis. One of the largest of these ramifications comes off near the os scaphoides, and cruises along the internal margin of the abductor pollicis to its anterior end; another becomes superficial on the sole of the foot, between the abductor pollicis and the flexor brevis digitorum, and goes forward as far as the other.

The External Plantar Artery (*art. plantaris externa*) is the continuation of the posterior tibial, and diverges from the internal plantar towards the outer margin of the sole of the foot, between the flexor brevis digitorum pedis and the flexor accessorius. Having reached the internal margin of the abductor minimi digiti, it advances along the latter to the base of the metatarsal bone of the fourth toe; it then makes a curvature forwards and inwards across the metatarsal bones, between the tendons of the flexor longus digitorum and the interosseous muscles, to the first metatarsal interval, where it is joined by the anterior tibial artery from above. This curvature is the Arcus Plantaris, of which the concavity is behind and inwards.

The external plantar artery is distributed as follows:—

Shortly after its origin, it detaches a branch which goes backwards and outwards, and which, keeping close to the os calcis in front of its tuberosity, is distributed to the heads of the muscles arising from it, and to the outer surface of the heel; it also sends an arteriole along the external edge of the abductor minimi digiti.

At the base of the fourth metatarsal bone arises a branch called the External Digital Artery of the Little Toe. It goes at first deeply along the internal margin of the muscles situated on the fifth metatarsal bone, and, afterwards, at the head of the latter, it gets between them and the bone, and is distributed along the external margin of the little toe.

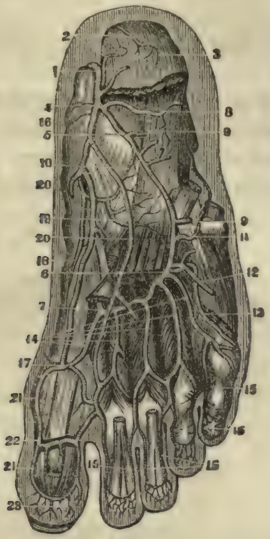
The four Digital Arteries of the foot arise next successively from the arcus plantaris, at or near the metatarsal intervals. They run along the inferior surface of the interosseous muscles, getting to the bases of the first phalanges above the transversalis pedis. Each artery there bifurcates, so as to supply the opposed surfaces of the adjacent toes, in the same way that the digital arteries of the hand are distributed.

The digital artery of the first metatarsal interval which comes from the internal extremity of the arcus plantaris, where the anterior tibial artery joins the latter, goes forwards concealed by the flexor brevis of the great toe: just behind the sesamoid bones, it sends a branch which supplies the internal side of the great toe, being its internal digital artery, and anastomoses with the internal plantar artery. What remains of it is still a trunk of considerable magnitude, which, advancing to the space between the first phalanx of the great toe and of the toe next to it, there bifurcates, as mentioned, so as to supply the opposite sides of these two toes.

The Perforating Arteries, as they are called, are of two kinds, the anterior and the posterior. The former arise from the convexity of the plantar arch, and being destined principally to the interosseous muscles,

anastomose at the anterior end of the latter with the branches from the metatarsal artery, which supply their superior surface. The posterior

Fig. 242.



The deep-seated branches of the Arteries on the Sole of the Foot.—1. Posterior tibial artery by the side of the os calcis. 2. Branches to the calcis. 3. Branch of the posterior peroneal artery. 4. Bifurcation of the posterior tibial into the internal and external plantar. 5. Origin of the external plantar artery. 6. Point where it forms the plantar arch. 7. Anastomosis of the anterior tibial with the plantar arch. 8, 9, 10. Muscular branches of the external plantar artery. 11. Anastomosis of this artery with the metatarsal. 12, 13. External digital of the little toe. 14. Digital arteries of the other toes. 15, 15. Their distribution on the toes. 16. Origin of the internal plantar artery. 17. Its anastomosis with the arcus plantaris. 18, 19, 20. Muscular branches of the internal plantar artery. 21. Digital of the big toe, as formed by the anastomosis of the internal plantar and arcus plantaris. 22. Sub-articular branch of the great toe. 23. Anastomosis in the pulp of the toe.

perforating arteries come also from the plantar arch, and penetrating the posterior end of the interosseous spaces, anastomose also with the metatarsal arteries on the dorsum of the foot.

The preceding trunks of the internal and of the external plantar arteries are the principal ones which are found in the bottom of the foot; but from them there arise an immense number of arterioles, which, descending vertically between the interstices of the muscles and of the aponeurosis plantaris, supply the adipose matter and the skin of the sole of the foot, so as to render them extremely vascular.

CHAPTER III.

OF THE VEINS.

THE veins of the body, assembling from different points, unite successively into the ascending and into the descending vena cava, which discharge their blood into the right auricle of the heart. The veins of

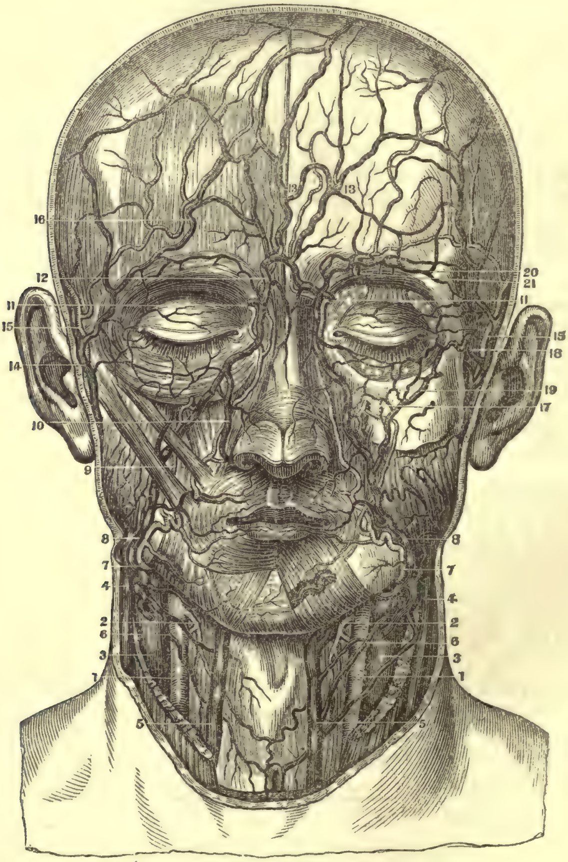
the head, of the upper extremities, and of the thorax, run into the descending cava, while the veins of the abdomen and of the lower extremities concur to form the ascending cava.

SECT. I.—OF THE VEINS OF THE HEAD AND NECK.

Many of these veins are described elsewhere with the encephalon and with the eye, to which accounts the reader is referred. The others are more superficial, and arise as follows:—

The Facial Vein (*vena facialis*) observes the course of the facial

Fig. 243.



A front view of the relative positions of the Veins and Arteries of the Face and Neck.—1. Primitive carotid artery. 2. Superior thyroid artery. 3. Internal jugular vein. 4. External jugular vein. 5. A branch known as the anterior jugular vein. 6. Superior thyroid vein. 7. Facial artery. 8. Facial vein. 9. Zygomatic branch of the facial artery. 10. Nasal branch of the facial vein. 11. Anastomosis of the facial artery and vein with the corresponding ophthalmic vessels. 12. Venous arch above the nose. 13. Frontal vein. 14. Temporal vein. 15. Temporal artery. 16. Frontal branches of the temporal artery and vein. 17. Infra-orbitar vessels. 18. Transverse branch of the temporal vein. 19, 20. Venous anastomosis around the eyelids. 21. Frontal branches of the ophthalmic vessels.

artery, being placed behind the latter. It arises upon the forehead by a considerable number of roots, which unite into a single trunk called the frontal vein. This vein descends from the forehead, over the root of the nose, along the internal canthus of the orbit. It there receives reinforcements from the eyelids, and anastomoses with the ophthalmic vein; descending afterwards, in the same way with the facial artery, and taking the name of facial vein, it receives successively the veins from the nose, from the outer side of the orbicularis palpebrarum, from the upper and lower lips, and from the muscles and the integuments of the face. It descends to the neck at the anterior margin of the masseter muscle, and is then augmented by the ranine, the submental, and the inferior palatine veins, and immediately afterwards goes into the internal or the external jugular vein.

The Ranine Vein (*vena ranina*) arises at the point of the tongue, and then goes along its under surface, where it can be readily seen by turning up the end of the tongue. It joins the facial near the posterior margin of the mylo-hyoideus muscle.

The Submental Vein (*vena submentalis*) arises by ramuscules from the sublingual and the submaxillary gland, and from the contiguous muscles. It joins the facial vein a little below the last: sometimes it runs into the superior thyroidal vein.

The Inferior Palatine Vein (*vena palatina inferior*) arises principally from the soft palate and from the tonsil gland, but receives a few twigs from the contiguous parts. It corresponds with the inferior palatine artery, a branch of the dorsal lingual (*dorsalis linguæ*); descends the pharynx along side of it, and terminates in the trunk of the facial near the last.

The Lingual Vein (*vena lingualis*) has its origin from a plexus of veins situated on the root of the tongue under its lining membrane, between the epiglottis and the foramen cæcum: branches are also sent to it from the muscular structure of the tongue, from the sublingual gland and from the adjacent muscles, and it anastomoses with the vena ranina. It goes backwards between the hyoglossus and the mylo-hyoideus muscle, along the superior margin of the os hyoides, and then discharges into the internal jugular vein near the facial.

The Pharyngeal Vein (*vena pharyngea*) arises from a plexus of veins belonging to the pharynx, and discharges either into the lingual or into the internal jugular near it.

The Superior Thyroid Vein (*vena thyroidea superior*) corresponds with the distribution of the superior thyroid artery, in the origin of its primitive roots. Having collected the latter into one or more trunks, it passes upwards and backwards beneath the sterno-hyoid and thyroid muscles, and discharges itself into the upper part of the internal jugular, or into one of the large branches of the external jugular.

The Occipital Vein (*vena occipitalis*) arises from the branches of the occipital artery, and following the course of the latter, beneath the muscles connected with the mastoid process of the temporal bone, it is discharged into the upper part of the internal jugular or of the external: more rarely into the latter.

The Diploic Veins (*venæ diploicæ*) have been described in the account of the bones of the cranium as situated between the two tables, in the diploic structure, and commence by very fine capillary tubes from its lining membrane. The one in the frontal bone discharges itself into the frontal vein; that in the occipital bone into the occipital vein, and the two in the parietal bone into the deep temporal veins. They do not open each by one orifice, but by several, which make their terminations not very distinct or abrupt: besides which, they communicate freely by a crowd of ramuscules, with the veins of the scalp on the outside, and with those of the dura mater internally.

The Superficial Temporal Vein (*vena temporalis superficialis*) corresponds with the temporal artery, and takes its rise from the terminating ramifications of the latter. It is immediately below the skin. Its branches communicate freely with each other, and with the branches of the frontal and of the occipital vein: at the zygoma it receives the trunk of the Middle Temporal Vein, which, collecting the blood from the temporal muscle and other parts within the zygoma, perforates the temporal fascia to discharge itself into the superficial temporal vein.

The Temporal Vein (*vena temporalis*), which is formed by the junction of the middle and the superficial temporal, descends over the root of the zygoma, in company with the artery, and penetrates, like the latter, through the substance of the parotid gland. It is joined, near the neck of the lower jaw, by the internal maxillary vein. It is also joined, in its descent through the parotid gland, by the anterior auricular veins, by the parotid veins, and by the transverse facial, all of which correspond with the arteries of the same name. The temporal vein, on issuing from the parotid gland, immediately afterwards becomes the External Jugular; but, occasionally, it ends wholly, or in part, in the Internal Jugular.

The Internal Maxillary Vein (*vena maxillaris interna*) is derived from the terminating ramifications of all the arteries into which the internal maxillary is divided; it is, therefore, composed of the spheno-palatine vein, which brings the blood from the nose, of the infra-orbital, of the pterygoids, inferior maxillary, deep-seated temporal, and so forth, with the exceptions of the vein, which might belong to the middle artery of the dura mater, but which does not exist according to Portal and to Hippolytus Cloquet. By the aid of the spheno-palatine vein, the internal maxillary communicates with the sinuses in the bottom of the cranium, by branches, called the Emissary Veins of Santorini,[1] which pass through the foramen ovale, rotundum, and spinale.

[1] Obs. Anat. chap. iii. p. 74.

It also communicates with the plexus of veins on the side of the pharynx.

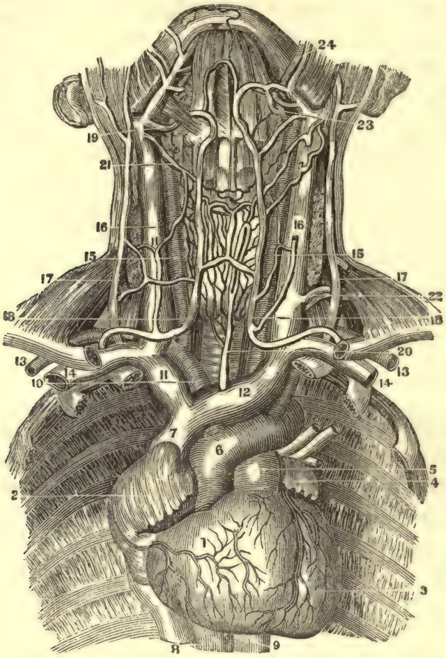
The External Jugular Vein (*vena jugularis externa*) is generally the continuation of the temporal. It descends on the neck almost vertically, between the platysma myoides and the sterno-mastoideus, in the direction of the fibres of the first, and crossing those of the latter obliquely. Just behind the clavicle, at the external margin of the sterno-mastoideus, it opens into the subclavian vein, in front of the scalenus anticus muscle. Sometimes, instead of one trunk only, there are two or three, which unite at a variable distance above the subclavian. This vein varies also in its size, and in the branches from which it is made up: sometimes it receives the facial vein, and on other occasions the latter runs, as stated, into the internal jugular. The condition and arrangement of the internal and external jugulars are, indeed, so inconstant, in regard to the trunks that compose them, that it is scarcely possible to give more than a very general description of them with admissible accuracy.

The external jugular, in going down the neck, anastomoses more or less with the internal jugular, either directly or by its branches: one of these anastomoses is found near the angle of the lower jaw, about the trunk of the facial vein, and is so large as to explain the difference of opinion among anatomists in regard to the latter's termination. Sometimes the occipital vein, or a large trunk from it, joins the external jugular. At the lower part of the neck, the external jugular is augmented by the superficial cervical veins. Some of these come from the lower part of the neck, near the shoulder, and join the jugular just above the clavicle; others are placed on the lower front part of the neck, above the sternum, and there form with each other a remarkable and an irregular plexus, consisting in numerous meshes. It frequently happens that the external jugulars of the two sides, just before they terminate, anastomose with each other by a large horizontal trunk, which runs just above the end of the sternum, in front of the sterno-mastoid, sterno-hyoid, and the sterno-thyroid muscles: this trunk, on other occasions, goes more deeply, and behind these muscles, from one subclavian vein to another, or to a jugular; its mode of attachment is, indeed, much varied: when it exists, however, it frequently receives several of the superficial veins of the neck, and the inferior thyroidal.

The Internal Jugular Vein (*vena jugularis interna*) extends from the basis of the cranium to the internal margin of the first rib, at the insertion of the scalenus anticus muscle. The lateral sinuses of the dura mater, receiving ultimately all the blood of the brain, of the eye, and a portion of that of the nose, convey it from the cranium through the posterior foramina lacera; where they are joined to the upper end of the internal jugular veins, the lining membrane of each sinus being continuous with that of its respective vein. Each vein is somewhat enlarged at its commencement, which is therefore called its Gulf or Sinus: the right vein is frequently larger than the left. The internal jugular then descends in front of the transverse processes of the ver-

tebræ of the neck, on the outer side of the internal and of the primitive carotid artery, and of the pneumogastric nerve. It is concealed above

Fig. 244.



A view of the Heart, with the Great Vessels of the Neck *in sitû*.—1. Right ventricle of the heart. 2. Right auricle. 3. Left ventricle. 4. Left auricle. 5. Pulmonary artery. 6. Arch of the aorta. 7. Descending vena cava at its entrance into the right auricle. 8. Ascending vena cava. 9. Thoracic aorta. 10. Arteria innominata. 11. Right brachio-cephalic vein. 12. Left brachio-cephalic vein. 13. Section of the subclavian artery. 14. Section of the subclavian vein. 15, 15. Primitive carotid arteries. 16, 16. Internal jugular veins. 17, 17. External jugular veins. Between these veins is seen the section of the sterno-cleido-mastoid muscle. 18. The trunk formed by the superficial cervical veins, known sometimes as the anterior jugular vein. 19. A branch from it to the facial. 20. Main trunk from the inferior thyroid veins. 21. Superior thyroid vein. 22. Transverse cervical artery and vein. 23. Lingual artery and vein. 24. Facial artery and vein.

by the styloid process of the temporal bone, and the muscles belonging to it; it is crossed, half way down the neck, by the omo-hyoideus muscle; and, in the greater part of its course, is beneath, and nearly parallel with, the anterior edge of the sterno-mastoideus. Having got behind the sternal end of the clavicle, it is joined at the internal edge of the scalenus anticus by the subclavian vein, and the union of the two forms the vena innominata.

The internal jugular receives frequently the large anastomotic branch, just alluded to, from the external jugular, at the under margin of the parotid gland, between the digastric muscle and the lower jaw, and it is in this vicinage that it is generally reinforced by the Occipital; the Lingual; the Facial; the Pharyngeal; and the Superior Thyroidal Veins, that have been described.

The Vena Innominata, or Brachio-Cephalic Vein, is the trunk formed on either side by the junction of the subclavian with the internal jugular.

On the right side it looks like the continuation of the internal jugular, and descends in contact with the right pleura, behind the right side of the sternum, for the distance of an inch or thereabouts. On the left side it crosses behind the superior end of the sternum, descending obliquely in this course, from left to right, until it joins the trunk on the right side. It lies in front of the great vessels proceeding from the arch of the aorta; and is much longer than the trunk of the other side. A common name for it is the Transverse Vein.

The Vena Cava Superior, or Descendens, arises from the junction of the two venæ innominatæ. It begins between the cartilage of the first rib on the right side, and the arch of the aorta, and descends to the superior posterior part of the right auricle, into which it empties itself. Its course is not entirely vertical, but inclining somewhat to the left side and forward. It is about three inches long. The superior third of it is free, and is in contact on the right with the pleura, and on the left with the arteria innominata; the remaining portion of it is invested by the pericardium, and has the aorta on its left anterior face.[1]

The following venous trunks discharge into the venæ innominatæ, or into the descending cava. The Inferior Thyroidal; the Vertebral; the Superior Intercostal; the Internal Mammary; the Vena Azygos; and some others of smaller size.

1. The Inferior Thyroid Vein (*vena thyroidea inferior*) arises from the inferior part of the thyroid gland by many small roots, which anastomose with those of the opposite side. It descends in front of the trachea, involved in the loose cellular and fatty matter lying upon it, and empties itself into the left brachio-cephalic vein, or Transverse Vein.

There is occasionally another thyroid vein, called the middle, which discharges itself into the lower part of the internal jugular.

2. The Vertebral Vein (*vena vertebralis*) is placed in the same canal with the vertebral artery. At its upper extremity it anastomoses with the occipital sinus, by a branch lodged in the posterior condyloid foramen. In its descent of the canal of the transverse processes, it communicates at each intervertebral foramen with the vertebral sinuses, and also receives a branch from the muscles of the neck. It issues at the sixth transverse process, and going on the right side behind the subclavian artery, but on the left in front of it, is finally emptied into the commencement of the vena innominata.

3. The Superior Intercostal Vein (*vena intercostalis superior*) is on the right side an inconsiderable trunk, sometimes deficient, which commences by branches belonging to the first two intercostal spaces, and empties into the vena innominata just below the vertebral. On the left side it is much larger, and arises from the six or eight superior

[1] In some very rare cases, there have been two descending venæ cavæ, one for the right side and the other for the left. J. F. Meckel.

intercostal spaces. It lies on the left side of the bodies of the upper dorsal vertebræ, and at each intercostal space, as it ascends, receives its contribution of an intercostal vein, corresponding with the intercostal artery; it also receives branches from the œsophagus, and about the third dorsal vertebra the left bronchial vein is discharged into it. Issuing from the thorax above, it discharges into the left vena innominata near its commencement.

4. The Internal Mammary Vein (*vena mammaria interna*) arises from the terminating branches of the internal mammary artery, and in its situation and course corresponds with the latter. It is reinforced by small branches from the diaphragm, the pericardium, and the thymus gland. Each internal mammary vein discharges itself on its respective side into the vena innominata near the superior intercostal.

5. The Vena Azygos is placed in the posterior mediastinum, on the right anterior margin of the Dorsal Vertebræ, and discharges itself in making an arch forwards over the root of the right lung, into the descending cava, just above the introduction of the latter into the pericardium. Its orifice there is supplied with a membranous duplicature or valve, which prevents the blood once discharged from re-entering it. The valve is sometimes double, and also somewhat removed from the orifice. It was the observations of these valves, first of all, which called the attention of Sylvius and of Charles Etienne to their existence in other veins.

This vein begins in the abdomen, either by an anastomosis with the ascending cava, or with the upper lumbar vein; it then ascends into the thorax through the aortic orifice of the diaphragm, and, continuing to mount upwards beneath the pleura, it lies on the right side of the thoracic duct, and crosses in front of the intercostal arteries of the right side. In this course, it receives from the ten inferior intercostal spaces of the right side, their respective intercostal veins, corresponding in their origin and course with the intercostal arteries. About the sixth vertebra of the back, it receives a trunk (*vena hemi-azygos*) which is formed from the four or six lower intercostal veins of the left side, and commences in the abdomen by anastomosis with the left emulgent vein or the left superior lumbar, and which gets into the thorax either through the aortic orifice of the diaphragm, or through a special opening to the left of it. The vena azygos also receives some small ramifications from the œsophagus, and near the fourth dorsal vertebra the right bronchial vein is discharged into it. Other small ramifications join it from the parietes of the descending cava, of the aorta, and of the right pulmonary artery. Branches also proceed to it, or to the intercostal veins, from the interior of the vertebral canal at each intervertebral foramen.

This vein is commonly spoken of by anatomists as forming a great anastomosis between the ascending and the descending cava. The tendency to establish this anastomosis is strikingly confirmed by a preparation made by myself, when I was a student in this institution in

1813. It is now in the Anatomical Cabinet. In it the ascending cava, instead of emptying, as usual, into the lower part of the right auricle, ascends on the right side of the dorsal vertebræ, and, supplanting in situation and office the vena azygos, discharges itself into the descending cava, in a manner corresponding with the vena azygos, by making a curvature forwards over the root of the right lung.

The Sinuses of the Vertebral Column[1] (*sinus columnæ vertebralis*) are situated in the vertebral cavity, on the posterior face of the bodies of the vertebræ, and in front of the dura mater of the spinal marrow. They are two long veins, one at each margin of the posterior vertebral ligament, and extend from the foramen magnum occipitis to the inferior end of the sacrum. They are maintained in their places by a loose cellular tissue between the bones and the dura mater, and therefore, unlike the sinuses of the brain, are entirely independent of the dura mater.

These sinuses are small where they begin in the sacrum, and are there merely two cylindrical veins surrounded by a loose cellular substance, and which have an anastomosis between them. In ascending the spine, they enlarge, but not continually, as they are somewhat smaller in the cervical than in the dorsal vertebræ. On the body of each vertebra they are rather larger than on the intervertebral substance: this gives them a knotted appearance, which is especially distinct in the loins.

At the middle of each vertebra, they are joined to one another by transverse branches, which pass beneath the posterior vertebral ligament, and receive the veins belonging to the cellular structure of the bone. Externally, they communicate with the vertebral veins in the transverse processes of the neck, with the intercostal, and with the lumbar veins, as an opening occurs between the adjacent vertebræ. They also receive many delicate veins from the dura mater of the spine. These two trunks terminate at their upper end by an anastomosis, through the anterior condyloid foramen, with the internal jugular: they also terminate by anastomosis with the anterior occipital sinus and with the vertebral veins.

From the arrangement of these sinuses, it appears that each bone of the spine has its own venous system or circle; which also is the case in regard to the corresponding section of the medulla spinalis in early life, when it occupies the whole length of the spine. Each of these circles, by the freedom of their anastomoses, therefore, forms a link in a long chain of venous circles belonging to the structure of the spine.

SECT. II.—OF THE VEINS OF THE UPPER EXTREMITIES.

The veins of the upper extremities are superficial and deep-seated, and arise from the distribution of the arteries.

The Deep-seated Veins are found in company with each arterial ramification, there being two veins to one artery generally. We thus

[1] G. Breschet, Essai sur les Veines du Rachis, Paris, 1819.

have them observing the course of the arteries of the hand, of the fore arm, of the arm and of the shoulder. At the bend of the arm, the two radial and the two ulnar veins coalesce into the two brachial veins, which attend the brachial artery, one on each of its sides, and at intervals throw anastomotic branches across it. Sometimes, but one of these trunks exists, with the exception of the lower part of the arm, where there are most commonly two. The trunk (or trunks, as the case may be) is joined by the basilic vein, at a point varying from the middle of the arm to the axilla. These venæ comites, or satellites, are invariably called after the arteries which they attend, and having no difference from the latter in relative situation, a farther description of them may be dispensed with.

Fig. 245.

The Superficial Veins on the front of the Upper Extremity.—1. Axillary artery. 2. Axillary vein. 3. Basilic vein where it enters the axillary. 4, 4. Portion of the basilic vein which passes under the brachial fascia—a portion of the vein is freed from the fascia. 5. Point where the median basilic joins the basilic vein. 6. Points to the posterior basilic vein. 8. Anterior basilic vein. 9. Point where the cephalic enters the axillary vein. 10. A portion of the same vein as seen under the fascia; the rest is freed from it. 11. Point where the median cephalic enters the cephalic vein. 12. Lower portion of the cephalic vein. 13. Median cephalic vein. 14. Median vein. 15. Anastomosing branch of the deep and superficial veins of the arm. 16. Cephalica-pollicis vein. 17. Subcutaneous veins of the fingers. 18. Subcutaneous palmar veins.

The Superficial Veins lie between the skin and the adjoining aponeurosis, and are considerably larger than the preceding. Their earliest roots are seen on the back of the fingers; they then appear on the back of the hand, on the posterior of the lower end of each interosseous space. There are commonly six trunks in all: the one on the ulnar side of the hand, and the three next to it, converge towards the middle of the back of the carpus into a single trunk; the two others, one of which comes from the thumb and the other from the back of the fore finger, converge to the outer end of the carpus, and there form a single trunk also. Between the several trunks, there are frequent anastomoses, and they finally assemble into two principal branches called the Cephalic and the Basilic Vein.

The Cephalic Vein (*vena cephalica, radialis cutanea*) is the trunk which comes from the thumb and from the fore finger, and has at first the name of Cephalica Pollicis. It ranges along the anterior and radial margin of the fore arm, and receives, continually, an augmentation from small collateral branches on the back of the fore arm. Having reached the bend of the arm, it then ascends along the external margin of the biceps flexor cubiti till it touches the lower margin of the pectoralis major muscle; it then rises superficially along the interstice between this muscle and the deltoid, to within eight or ten lines of the

clavicle, where it dips down to join the axillary vein. Along the arm, it receives some small secondary cutaneous branches.

The Basilic Vein (*vena basilica, cubitalis cutanea*) is larger than the cephalic, and begins by the trunk which comes from the ulnar side of the back of the hand, and is first called the Vena Salvatella. On the fore arm, the basilic frequently consists in two long trunks, the anterior and the posterior; in this case the posterior is the principal one, and runs along the internal posterior edge of the ulna, until it comes to the bend of the arm; it then mounts over the latter, rising obliquely in front of the internal condyle. The anterior branch begins near the palm of the hand, runs up in front of the ulnar side of the fore arm, and discharges itself into the median basilic vein over the brachial artery in front of the bend of the arm. These two trunks, or one, as the case may be, receive the cutaneous veins belonging to the ulnar side of the fore arm.

Above the elbow joint, the basilic gets below the fascia of the arm at the inner edge of the biceps, and about the middle of the arm becomes, by its junction with the venæ satellites, the Brachial Vein; but sometimes, as mentioned, this junction occurs much higher up.

The Median Vein (*vena mediana*) arises, by branches, from the wrist, from the palm of the hand, and from the middle of the front of the fore arm. It forms a trunk which ascends in front of the fore arm, and which, a few inches below the bend of the arm, divides into two. One branch runs outwardly, in ascending for an inch or two, and joins at the outer side of the bend of the arm, the cephalic vein; it is called, therefore, the Median Cephalic. The other branch continues to ascend, and, crossing obliquely the direction of the brachial artery, it receives, near the latter, the anterior trunk of the basilic vein, and somewhat above the bend of the arm, runs into the proper basilic vein: it is called the Median Basilic.

There is frequently a departure from the preceding arrangement of the median vein; the most common is where a trunk begins from the cephalic below the bend of the arm, and runs obliquely in front of the latter to join the main trunk of the basilic above the elbow joint. This oblique trunk stands in the place of median cephalic and median basilic, and receives successively the median, the anterior, and the posterior basilic. It is frequently the median itself, and has a short anastomosis, in such case, with the cephalic vein.

The Superficial Veins anastomose frequently with each other, so that, when they are all fully injected, a plexus of veins is found immediately beneath the skin of the upper extremity from one end to the other. The Venæ Satellites also anastomose frequently by branches which cross the artery to which they belong. At the bend of the arm, at the wrist, and in different places, there are also anastomoses between the deep-seated and the superficial veins.

The Axillary Vein (*vena axillaris*) results from the union of the basilic with the brachial vein. It is below and in front of the axillary

artery being included in the same sheath with it, and also involved with the axillary plexus of nerves. It retains its name from the lower margin of the arm-pit to the under surface of the clavicle, where, like the artery, it is then called subclavian. In this course it is joined near the points where the corresponding arteries are given off, by the Anterior and the Posterior Circumflex Vein; by the Scapular, and by the External Thoracics.

The Subclavian Vein (*vena subclavia*) extends from the termination of the axillary to the vena innominata, where the latter is constituted by the junction of the internal jugular with the subclavian. In its course it goes under the subclavian muscle, and is in front of the subclavian artery from the beginning, but near it: afterwards it is separated from the artery by the latter going between the anterior and the middle scalenus muscle; whereas the vein runs over the anterior end of the first rib, in front of the insertion of the scalenus anticus.

The Subclavian Vein is joined by some branches coming from the shoulder and from the lower part of the neck; and, at the outer margin of the origin of the sterno-mastoid muscle, it is augmented by the addition to it of the external jugular. It terminates as mentioned, at the internal margin of the scalenus anticus, in the vena innominata.

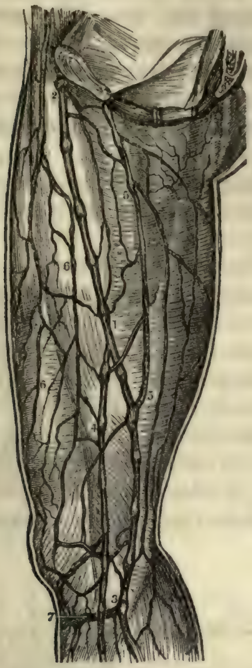
SECT. III.—VEINS OF THE LOWER EXTREMITIES.

The veins of the lower extremities, like those of the upper, are deep-seated and superficial. The former follow the course of the arteries, and are the venæ satellites; there being, for the most part, two veins for every artery as far up as the ham, and also as regards the muscular branches of the thigh. These venæ satellites adhere closely to the artery, and are separated from each other by the latter. They also have frequent anastomoses with each other across the artery.

The Popliteal Vein (*vena poplitea*) is a single trunk formed by the union of the anterior tibial, the posterior tibial, and the peroneal veins. It begins on the posterior part of the head of the tibia, and extends upwards through the ham to the perforation in the adductor magnus muscle, which transmits the femoral artery. It is situated on the posterior face of the popliteal artery, to which it closely adheres; and behind it is the popliteal nerve, the continuation of the great sciatic.

The Femoral Vein (*vena femoralis*) is the continuation upwards of the popliteal: it at first is placed behind the artery, but in a short space it gets to its interior face, and continues to adhere to it, in that situation, up to Poupart's ligament, where it becomes the external iliac vein. At the usual distance below the groin, where the arteria profunda is given off, the femoral vein receives the vena cruralis profunda, which is derived from the branches of this artery, and is rather more superficial than it; the two, however, adhere closely together. Just below Poupart's ligament the femoral vein receives

Fig. 246.



A view of the Superficial Veins of the Thigh, as seen on its inner side.—1. Great saphena vein. 2. Point where it traverses the fascia to enter the femoral vein. 3. Lower femoral portion of the saphena; in its whole course it is on the inner edge of the sartorius muscle. 4. A collateral branch of the saphena. 5, 6. Anastomosing branches. 7. An anastomosis which receives the veins of the leg just below the knee.

several small branches of veins corresponding with the external pudic arteries.

The Small Saphena (*vena saphena minor, externa*) commences by several small branches near the external side of the top of the foot, and the external ankle; a trunk is formed by them behind the latter, which ascends along the tendo-Achillis and the posterior face of the gastrocnemius muscle, collecting several small veins from the back of the leg in its course. This vein is superficial in its whole length, being placed immediately beneath the skin. In the ham, it goes for a short distance along the internal face of the popliteal nerve, and then makes a dip through the adipose matter, there to empty into the popliteal vein.

It is said, by Portal, that the branches of this vein become very apparent in persons who suffer from podagra, and from enlargement of the lymphatic glands in the ham. In such case, their distension has been relieved by the application of leeches along them.

The Great Saphena (*vena saphena magna, interna*) is also superficial, has its primitive roots coming from the internal upper part of the foot, and from the sole of the latter. These branches are as-

sembled into a trunk which passes upwards in front of the internal ankle, then ascends along the internal face of the leg, in a line corresponding with the posterior margin of the tibia. The great saphena continues its ascent over the internal condyle near its posterior part, and then mounts up the internal face of the thigh, in a line corresponding nearly with the internal margin of the sartorius muscle. It finally terminates in the femoral vein, about twelve or eighteen lines below Poupart's ligament, an opening being left in the fascia femoris for this purpose.

Fig. 247.

The Superficial Veins on the inner side of the leg.—1. The saphena major at the inside of the knee. 2. A collateral branch of the saphena major on the leg. 3. The anastomosis of the veins just below the knee. 4. Internal saphena at the middle of the calf of the leg. 5. Origin of the saphena vein at the ankle joint. 6. Anastomosing branch of the saphena major and minor. 7. Branches on the back of the leg. 8. The great internal vein of the foot. 9. The arch of veins on the metatarsal bones. 10. A branch from the heel. 11. Branches on the sole of the foot.

In the whole of this course the great saphena is situated between the skin and the fascia of the lower extremity; it is, consequently, so superficial, that in persons of moderate corpulency it is very visible, and by slight pressure above, along with the erect position, it becomes so much swollen, that it is easily opened with the lancet where it passes over the internal ankle. It receives, in its ascent, small branches from the anterior and posterior part of the leg, from the corresponding

surfaces of the thigh, and near its termination it gets a few of the external pudendal veins.

When the great and the small saphena veins are successfully injected, their branches are seen to form a considerable number of anastomoses, which thereby produce a remarkable venous net-work, just beneath the skin of the whole inferior extremity.

SECT. IV.—VEINS OF THE ABDOMEN.

The External Iliac Vein (*vena iliaca externa*), being the continuation of the femoral vein, passes into the abdomen, under Poupart's ligament, and in contact with the internal margin of the external iliac artery. It there receives the epigastric, and the circumflex iliac veins, corresponding with the arteries of the same name; it also receives a vein of some size, which enters by the abdominal canal in adhering to the spermatic chord, and which comes from the coats of the testicle.[1] It keeps then along the internal side of the artery, somewhat behind it, at the superior margin of the pelvis, and joins the hypogastric vein opposite to the sacro-iliac junction, and thereby forms the common iliac vein.

The Hypogastric Vein (*vena hypogastrica*, *iliaca interna*) comes from the inferior part of the pelvis in front of the sacro-iliac junction, and in company with the hypogastric artery. It arises by branches, corresponding with the distribution of the latter to the viscera of the pelvis, and to its external parts; these branches are so numerous at particular points, and have such frequent anastomoses, that they are formed into a Plexus. Thus, there is a hemorrhoidal plexus for the lower part of the rectum, a vesical for the bladder, a sacral for the sacrum, a pudendal for the parts of generation in the male, a vaginal for the vagina, and a uterine for the uterus of the female.

The Plexus Hemorrhoidalis, besides being connected with the hypogastric, also anastomoses with the branches of the vena portarum.

The Plexus Vesicalis is different in the two sexes. In man it commences at the extremity of the penis by several branches, which unite into two trunks of considerable size, the Venæ Dorsales Penis.[2] The latter go along the upper face of the penis, near or at its middle, to the symphysis of the pubes, continually receiving in this course small trunks from the integuments of the penis and from the scrotum. They then get into the pelvis between the root of the penis and the symphysis pubis, and continue horizontally backwards on the side of the prostate gland, of the vesiculæ seminales, and of the lower fundus of the bladder. They receive many branches from these parts, which, with the frequency of the anastomoses about here, constitute the vesical plexus. The latter, finally, discharges into the lower part of the hypogastric vein by two or more branches.

In the female the vesical plexus begins on the dorsum of the clitoris,

[1] H. Cloquet, Traité d'Anat.

[2] They are frequently found to join into a single trunk, called, in such case, the Vena Magna Ipsius Penis.

by several branches coming from it and from the vulva; they get into the pelvis under the symphysis pubis, and on the sides of the urethra and of the vagina, forming upon the lower part of the bladder, and on the side of the vagina, with the assistance of branches from these viscera, a remarkable plexus, which also empties into the internal iliac vein.

The Plexus Sacralis consists in an order of veins, anastomosing freely with each other, and corresponding with the middle and the lateral sacral veins. They communicate with the inferior end of the vertebral sinuses through the anterior sacral foramina; they also communicate with the hemorrhoidal and with the vesical veins. They terminate in the venous trunks, nearest the origin of the arteries from which they are derived.

The Plexus Pudendalis is derived from the branches of the internal pudic vein which go to the perineum, to the posterior part of the scrotum, and to the integuments of the under part of the penis. The trunk, formed by the assembling of these several ramifications, follows the course of the internal pudic artery to which it belongs, and gets into the pelvis at the lower part of the sciatic foramen, where it contributes to the formation of the hypogastric vein.

The Plexus Uterinus consists in a considerable number of veins, which are distributed upon the surface, and in the texture of the uterus; they are also found in abundance in the broad ligaments, where they anastomose with the ovarian veins.

The Plexus Vaginalis comes from the anterior parts of the organs of generation constituting the vulva, as the labia majora, minora, and so on. It also arises from the whole surface of the vagina, surrounds it completely, and anastomoses with the uterine veins.

The Gluteal, the Obturator, and the Ilio-Lumbar Veins, also contribute to the Hypogastric; their description conforms so nearly to that of the corresponding arteries, that it is unnecessary to detail it.

The Primitive Iliac Vein (*vena iliaca primitiva, communis*), formed by the junction of the External and of the Internal Iliac, extends from the sacro-iliac symphysis to the lower margin of the fourth lumbar vertebra, where it joins the corresponding trunk of the opposite side of the body, to form the commencement of the ascending vena cava. In this course the left one passes obliquely across the body of the fifth lumbar vertebra, and beneath the right primitive iliac artery.

The Vena Cava Inferior is situated on the front of the spinal column, to its right side, and extends from the lower part of the fourth lumbar vertebra (or, in other words, from the junction of the primitive iliac veins) to the under end of the right auricle of the heart, into which it empties. It is larger than the Descending Cava.

In its ascent it inclines very gradually to the right side of the spine, so as to reach the opening in the tendinous centre of the diaphragm, through which it passes just before it terminates in the auricle. It is bounded on the left side by the aorta, and ascends in front of the right crus of the diaphragm. Its lower extremity is crossed in front

by the root of the right primitive iliac artery; the ascending cava is also crossed in its ascent by the duodenum and the pancreas. Its upper extremity is behind the liver, and frequently passes through the substance of this viscus.

It receives the middle sacral, the lumbar, the spermatic, the emulgent, the capsular, the hepatic, and the phrenic veins.

The Middle Sacral Vein (*vena sacra media*) forms, as has been just mentioned in the account of the branches of the hypogastric vein, a part of the sacral plexus. Its trunk follows the course of the middle sacral artery on the front of the sacrum, and discharges into the commencement of the vena cava, in the fork formed by the junction of the primitive iliacs.

The Lumbar Veins (*venæ lumbales*) correspond with the lumbar arteries, and are commonly four or five in number on each side. Their primitive roots anastomose with the epigastric, the last intercostal, and the circumflex iliac veins; the dorsal branches of them also anastomose with the vertebral sinuses, through the intervertebral foramina. Their trunks pass along with the arteries, between the bodies of the vertebræ and the psoas magnus muscle, or through the fasciculi of the latter: those on the left side pass behind the aorta, in order to reach the vena cava, and are, consequently, longer than such as are on the right.

The Spermatic Veins (*venæ spermaticæ*). The right one extends from the testicle to the ascending cava, just below the emulgent veins; while the one on the left empties into the left emulgent vein. They are larger than the corresponding arteries, and present some peculiarities in the two sexes.

In the male, the extremities of these veins begin in the testicle, and issue from it through the tunica albuginea; some of them also arise from the epididymis. They anastomose with the superficial veins of the penis and of the scrotum, and, disengaging themselves from the tunica vaginalis, at its back part, are assembled into four or five anastomosing trunks, which envelop the vas deferens and the spermatic artery, and compose a principal part of the bulk of the chord. Having passed through the abdominal canal, they are reduced on each side to one trunk which creeps along the spermatic artery on the front of the psoas magnus muscle, and in company with the ureter. Somewhat below the kidney, the spermatic vein is again resolved into a sort of plexus, having frequent additions from the veins, in the adipose substance of the kidney, and some also from the branches of the vena portarum in the mesentery, and in the mesocolon. It then is reduced once more into a single trunk, which terminates as mentioned. The term Corpus Pampiniforme (vine-like) is, by some anatomists, limited to the last plexus formed by each spermatic vein, but it is also frequently extended to both.[1]

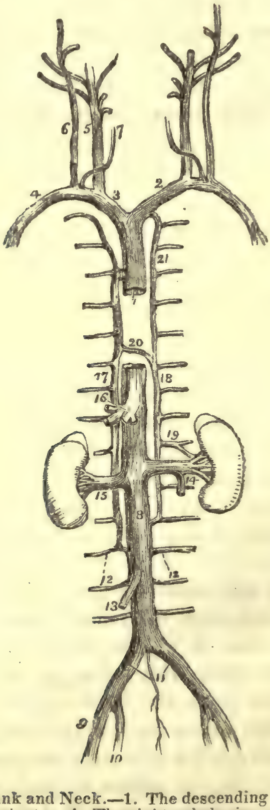
In the female, the spermatic vein is not so large as in the male; it

[1] H. Cloquet, Trait. d'Anat.

comes from the ovarium and from the side of the uterus, and is joined by some small branches from the round ligament of the uterus, and from the Fallopian tube. Passing outwardly between the laminæ of the broad ligament of the uterus, it crosses the external iliac artery, and in the subsequent part of its course is disposed of, as in the male.

The Emulgent Veins (*venæ emulgentes, renales*) are commonly two in number, one on each side, and extend horizontally from the fissure of the kidneys to the ascending cava. They are of a considerable size, and owing to the position of the vena cava, the left is much longer than the right, and crosses in front of the aorta. They open on their respective sides of the cava opposite to each other. The branches of which the emulgent vein is composed, coming from the ramifications of the corresponding artery in the kidney, assemble into the single trunk near the fissure of the kidney; this trunk is joined by some small veins

Fig. 248.



A view of the Veins of the Trunk and Neck.—1. The descending vena cava. 2. The left vena innominata. 3. The right vena innominata. 4. The right subclavian vein. 5. The internal jugular vein. 6. The external jugular. 7. The anterior jugular. 8. The inferior vena cava. 9. The external iliac vein. 10. The internal iliac vein. 11. The primitive iliac veins. 12, 12. Lumbar veins. 13. The right spermatic vein. 14. The left spermatic vein. 15. The right emulgent vein. 16. The hepatic veins. 17. The vena azygos. 18. The vena hemi-azygos. 19. A branch communicating with the left renal vein. 20. The termination of the hemi-azygos in the vena azygos. 21. The superior intercostal vein.

from the adjacent adipose matter and from the capsulæ renales, and on the left side, as mentioned, it is also joined by the spermatic vein.

The Capsular Veins (*venæ capsulares*) arise from the arteries spent upon the capsulæ renales, and are two in number, one on each side. That on the right discharges into the vena cava, while the one on the left empties into the left emulgent most frequently.

The Hepatic Veins (*venæ hepaticæ*) take their rise in the liver, and collect into three principal trunks, which, converging towards the ascending cava, discharge themselves into it, where it adheres to the posterior margin of the liver, immediately below the diaphragm. Two of these trunks come from the right lobe, and one from the left; moreover, there are several small hepatic veins which discharge themselves into the cava, and come principally from the Lobulus Spigelii.

The Inferior Phrenic Veins (*venæ phrenicæ inferiores*) arise in the diaphragm, from the corresponding arteries. They are two in number, and discharge into the ascending cava just above the hepatic veins.

SECT. V.—OF THE VENA PORTÆ OR PORTARUM.

The Vena Portarum is derived from the viscera of the abdomen, and presents the singularity of a vein ramifying through a gland (the liver), before its blood is returned to the general circulation. The arteries from which it draws its supply of blood are the superior and the inferior mesenteric, and the cœliac with the exception of its hepatic branch. The viscera of the abdomen which contribute to it are the spleen, the gall-bladder, the pancreas, the stomach, the small and the large intestines, the large and the small omentum.

a. The Splenic Vein (*vena splenica*) is formed by several branches, which, coming out separately from the fissure of the spleen, unite after a short course into a single trunk. This trunk runs in company with the splenic artery below it, along the superior margin of the pancreas; it is not quite so tortuous as the artery itself, and, proceeding from left to right, is joined to the superior mesenteric vein in front of the vertebral column.

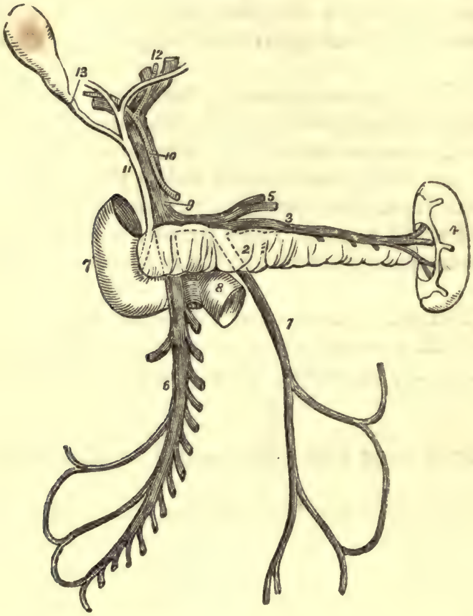
In this course, the splenic receives the small veins[1] (*venæ breves*), corresponding with the vasa brevia of the great end of the stomach, and then, successively, several branches from the pancreas. It likewise receives the gastric, or the superior coronary vein of the stomach, the right gastro-epiploic, and the left gastro-epiploic of the same viscus, all of which correspond with the arteries distributed to the latter.

b. The Inferior Mesenteric Vein (*vena meseraica inferior*) corresponds with the inferior mesenteric artery, and, consequently, derives its primitive branches from the rectum by the upper hemorrhoidal veins, which anastomose with the lower; from the sigmoid flexure of

[1] M. Bauer discovered, in 1824, valves in these vessels, contrary to the general analogy of the system of the Vena Portarum. His observations have been confirmed by H. Cloquet.

the colon; and from the left descending portion of the latter. The trunk formed by these branches ascends behind the peritoneum, between the left ureter and the aorta; and going up behind the pan-

Fig. 249.



A general plan of the Vena Portarum.—1. The inferior mesenteric vein. 2. The pancreas. 3. The splenic vein. 4. The spleen. 5. The gastric veins, opening into the splenic vein. 6. The superior mesenteric vein. 7. The descending portion of the duodenum. 8. Its transverse portion. 9. The vena portarum. 10. The hepatic artery. 11. The ductus communis choledochus. 12. The divisions of the duct and vessels at the transverse fissure of the liver. 13. The cystic duct.

creas, is discharged into the splenic vein an inch or two from its termination. But, like the veins belonging to the lesser curvature, and the right side of the stomach, it sometimes empties directly into the vena portarum, or into the upper end of the superior mesenteric.

c. The Superior Mesenteric Vein (*vena meseraica superior*) is the largest of the trunks which contribute to form the vena portarum. It is derived from the ramifications of the superior mesenteric artery upon the small intestines, the ileo-colic valve, the right ascending and the transverse colon. Its branches constitute in the mesentery and the mesocolon a vascular intertexture, forming arches and meshes adhering to the corresponding ones of the arteries. In the transverse mesocolon, it, like the artery, anastomoses with the inferior mesenteric vein. Its trunk being formed by the union of these several branches, ascends the mesentery, and goes in front of the duodenum, where the latter crosses the spine; immediately afterwards it gets behind the pancreas, and near its right end is joined by the splenic vein. It here, also, receives small branches from the duodenum, from the pylorus, and from the gall-bladder.

The trunk of the Vena Portarum being formed behind the pan-

creas by the union of the superior mesenteric with the splenic vein, extends, from this point to the transverse fissure of the liver, and is about four inches in length. It ascends obliquely from left to right, behind the second curvature of the duodenum, being bounded on the right side by the biliary ducts, and on the left by the hepatic artery where it is surrounded by a great many nervous filaments and lymphatic vessels, with all of which it is united by a common envelop of cellular substance, and of Peritoneum, called the Capsule of Glisson. Having reached the transverse fissure of the liver, it divides into two branches, which are each at a right angle to it, but in line with one another: they constitute the Sinus Portarum, of which the right branch being spent upon the great lobe, and the left upon the small lobe of the liver, are ramified almost to infinity through the structure of the latter. The terminating branches of the vena portarum empty into the venæ hepaticæ.

Several cases are recorded in the annals of anatomy in which the vena portarum, instead of going into the liver, discharged immediately into the ascending cava.[1] In such instances, the hepatic artery is much larger than usual. According to J. F. Meckel, notwithstanding they are anomalies, yet, as in most other cases of deviation from the general type of the human family, a striking analogy may be found between them and what occurs in some of the lower orders of animals. Here the analogy exists with the invertebrated animals.

CHAPTER IV.

OF THE PECULIARITIES IN THE CIRCULATORY SYSTEM OF THE FŒTUS.

Owing to the want of respiration in the fœtus, its circulation is conducted in a manner very different from that of the adult. Moreover, its parasitical life requires an alliance, through the organs of circulation, with the mother. Its peculiarities, therefore, may be studied under two heads: those which arise from the want of respiration, and those which are required for its nourishment. The peculiarities of the first order are situated in the thorax, and those of the second in the abdomen.

SECT. I.—OF THE PECULIARITIES OF THE FŒTUS, ARISING FROM THE WANT OF RESPIRATION.

The Heart, at a very short period after conception, so early as about the end of the first month, is sufficiently developed to be in a

[1] Lieutaud, Hist. Anat. Med. Huber, Obs. Anat. p. 34. Abernethy, Ph. Tr. 1793, part i. Lawrence, Med. Ch. Trans. vol. v.

state of great activity. The first indication of its existence, and indeed, of the life of the new animal, is a small tremulous point, called the Punctum Saliens, from its incessant motion. The muscular structure of it is soon evolved, and in a few weeks becomes very manifest. At the earliest visible period of the heart in the incubated egg, which affords a satisfactory analogy, it consists of two vesicles united by a canal (*Canalis Auricularis* of Haller). One of the vesicles is the right auricle; the other is the left ventricle, and is probably the first to pulsate. The aorta is also visible, as well as the venæ cavæ. The circulation, at this period, is very simple: the blood starting from the left ventricle, is propelled into the aorta; it is collected from the ramifications of the last into the two venæ cavæ, and thereby brought to the right auricle; it is then propelled by the right auricle through the canalis auricularis into the left ventricle, whereby its round is completed, and it then starts again. This is the most simple kind of circulation, and is found, in fact, during the whole life of such animals as do not breathe by lungs; for example, fish. As the gills in them take the place of lungs, a branch from the aorta, spent upon the gills, is sufficient for their purposes of respiration.

The terms right auricle and left ventricle have been used, because the cavities alluded to perform the functions of the adult state; but in the progress of the development of the heart, a partition begins to show itself which ultimately divides each of them into two distinct chambers, whereby we have a right auricle and a left one: a left ventricle and a right one; and the canalis auricularis is reduced from a canal into a short orifice, called Ostium Venosum, communicating from the auricles to the ventricles, and which is afterwards divided into two, one for either side of the heart. The partition between the ventricles is completed about the end of the second month of gestation, at a period when the aorta, from having been simple originally, is converted into two canals, one of which becomes the pulmonary artery. The partition between the auricles is not completed till birth. In cases of monstrosity, it is interesting to see how much the heart, at the end of uterine life, has still preserved this original type of simplicity. I have formerly dissected a double fœtus, where, from the parasitical character of one, no effort had been made for the development of the lungs of the latter: the consequence of which was, the parasite's heart consisted only of the right auricle and of the left ventricle, and the pulmonary artery had not been formed at all, there being but the single tube, the aorta, which led from the left ventricle, and had a sort of arrangement in its branches depending upon the tendency to form pulmonary arteries.[1]

At birth, the auricular septum has advanced so far that the communication between the two cavities is kept up only by a deficiency, called the Foramen Ovale. This foramen, marked by a depression on the right side, admits a small quill, when conducted obliquely through it, and is protected on the left side by a valve, the edge of which is upwards, and which, when applied, is just large enough to close the

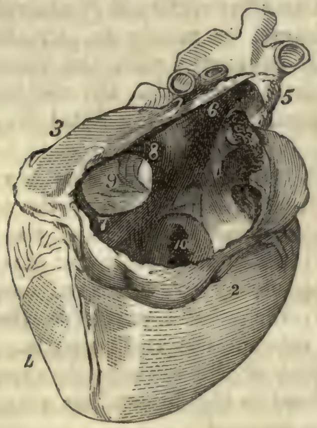
[1] For a detail of this case, see North American Medical and Surgical Journal, Philad. Oct. 1826.

foramen. The moment that the blood ceases to pass through the foramen ovale, which occurs at the first act of inspiration, the valve is applied, and the aperture grows up by the adhesion of its edge. The mechanism of this process is sufficiently simple. So long as the principal current of the blood was into the right auricle, the valve was pushed off from the side of the septum; but as breathing establishes, through the lungs, pulmonary veins, and left auricle, a current of circulation equivalent, both in quantity and force, to that through the two venæ cavæ and right auricle, a perfect equilibrium between the auricles is established, and the valve retains its place against the septum. Notwithstanding the incessant action of the auricles during all the subsequent periods of life, this equilibrium, in the force and time of their contraction, remains uniform: a circumstance proved, conclusively, by the health and strength of adults in whom the valve has never adhered to the day of their death; an observation made by many anatomists, and of which I have witnessed several examples. In one of them I passed two fingers readily from one auricle into the other, owing to the unusual size of the aperture.

The valve which closes the foramen ovale is, first of all, scarcely perceptible; but, as the fœtus advances in age, the valve advances in size, and is, indeed, large enough to close the foramen some time before birth. Its progress is upwards, and from its marginal adhesion as it advances, may be compared to a window sash in its frame. It is formed from the lining membrane of the two auricles, with an intermediate cellular substance.

The Valve of Eustachius, which exists also in the adult heart, is placed at the anterior semi-circumference of the orifice of the ascending

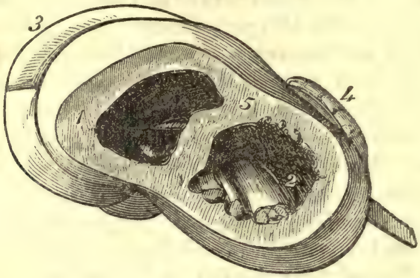
Fig. 250.



Fœtal Heart at nearly full time. Oblique view from below, the piece being suspended in an anatomical jar.—1. Right auricle. 2. Right ventricle. 3. Left auricle. 4. Left ventricle. 5. Aorta. 6. Descending vena cava. 7. Ascending vena cava. 8. Septum of auricles. 9. Foramen ovale, and its valve, being a part of the septum of auricles. The valve, as it is improperly called, grows from below upwards, and is seen to adhere at its edges. It is here not yet complete, as a small crescentic orifice, opening into the left auricle, is seen at its upper part, this being the last vestige of the foramen ovale, the latter being about to close up. On the right side a circular depression is seen, now the fossa ovalis; the valve rises up flush on the left side of the latter. 10. Ostium venosum of right auricle and ventricle.

vena cava in the right auricle, one of its ends adhering to the anterior margin of the foramen ovale. This valve, contrary to the one in the foramen ovale, is larger in proportion as the fœtus is younger, and,

Fig. 251.



Fœtal Heart at full time. Piece suspended horizontally in an anatomical jar. The ventricles cut through transversely to show them both of the same thickness at this period of life:—1. Right ventricle. 2. Left ventricle. 3. Left auricle. 4. Right auricle. 5. Septum ventriculorum of same thickness with other parts of ventricles.

when first observed, covers the whole orifice of the vena cava ascendens; its opening is in the direction of the current of blood in the latter. It also is formed by a duplicature of the lining membrane of the auricle, and, from its disposition, determines the blood of the ascending cava to flow through the foramen ovale into the left auricle, either wholly or in part, according to the period of gestation. Its obliquity also gives a direction to the blood of the descending cava, into the right ventricle from the right auricle. These uses of the Eustachian valve were pointed out by the celebrated Sabatier;[1] their value will be illustrated hereafter.

The ventricles of the Heart, at birth, have the same structure and internal arrangement as afterwards; they are remarkable, however, for being of equal thickness, or nearly so, an observation of Mr. John Hunter.[2] This fact is connected with the circumstance of their both contributing to the aortic circulation till respiration begins, owing to the pulmonary artery entering, during fœtal life, by its largest branch, into the aorta.

The Ductus Arteriosus constitutes this branch of the pulmonary artery, and is, in fact, the continuation of the trunk of the latter into the aorta, immediately behind the origin of the left subclavian artery. The right and the left pulmonary artery at this period are but inconsiderable trunks, incapable by any means of carrying off all the blood of the right ventricle; the greater part of it, therefore, is conveyed by the ductus arteriosus into the descending aorta. As the contraction of the ventricles, like that of the auricles, is synchronous, it is evident that the column of blood in the descending aorta is acted upon by both ventricles at the same moment.

The ductus arteriosus preserves the principle of a single circulation in the fœtus, which was first of all manifested by the two ventricles, constituting but one cavity, and by the aorta and pulmonary artery

[1] Traité d'Anat. vol. ii. p. 266. [2] Animal Economy.

being but one trunk. At the first act of inspiration, the lungs, which were before solid, and the thorax, which was compressed, are greatly augmented in volume by the introduction of air. The dilatation of the thorax, besides introducing air through the trachea, causes an increased flow of blood through the right and left pulmonary arteries, in order to fill the vacuum in the lungs. The pulmonary arteries become in that way permanently dilated, and the circulation is finally drawn off entirely from the ductus arteriosus, though this takes several weeks or months before it is completely accomplished. The ductus arteriosus in this time is continually contracting, and is at length converted into a ligamentous chord, like other arteries, whose circulation has been arrested.

These are the several peculiarities which distinguish the fœtal circulation, owing to the privation of respiration; and it is clear that the collective result is that of a circulation quite as simple as if the heart consisted of but two cavities; while, at the same time, it keeps this organ in a state of preparation for carrying on two distinct circulations, one pulmonary and the other aortic, from the moment that respiration begins: so that the whole mass of blood is, in subsequent life, brought successively under the influence of respiration, by having to pass unavoidably through the lungs.

SECT. II.—OF THE PECULIARITIES OF THE CIRCULATION OF THE FŒTUS CONNECTED WITH ITS NOURISHMENT.

The Umbilical Vein, one of the constituents of the umbilical chord, brings the blood from the placenta to the fœtus. This vessel is from three to four lines in diameter, and enters at the navel; thence it goes along the free margin of the suspensory ligament of the liver, and traverses the anterior half of the umbilical fissure, to terminate in the left branch of the sinus of the vena portarum. In this course through the liver, the umbilical vein sends off to the right and the left lobe several small branches. As the intestinal circulation of the fœtus is too small to send much blood through the vena portarum, it would be sufficiently correct to consider the sinus venæ portarum as the bifurcation of the umbilical vein: but, as this might introduce a confusion into the description, it will be better to retain the adult nomenclature.

The Ductus Venosus is a vein which occupies the posterior half of the umbilical fissure, and is about a line and a half in diameter. It arises from the left branch of the sinus portarum, opposite to the place where the umbilical vein entered or terminated, and is consequently in the same line with the latter. Traversing the posterior part of the umbilical fissure, it terminates in the left vena hepatica, as this hepatic vein is about joining the ascending cava, just below the tendinous centre of the diaphragm. Through this route much of the blood of the umbilical vein is carried directly to the right auricle of the heart, and then passed through the foramen ovale into the left auricle by the mechanism of the Eustachian valve.

From these considerations, it is evident that the umbilical vein really performs the office of a vein till it reaches the liver, but that there, much of its blood is spent through the portal circulation, upon the structure of this viscus; and that what remains is carried through the ductus venosus to the heart. Like other veins, it is furnished with valves, of which there are two; one at its termination in the sinus portarum, and the other at the cardiac extremity of the ductus venosus.[1] The establishment of respiration, by putting the circulation into other channels, likewise causes the obliteration and final conversion of the umbilical vein into a ligamentous chord. The valve, at the sinus portarum, prevents the blood from taking a retrograde course, and thereby keeping the umbilical vein open; the valve of the ductus venosus has the same effect upon the duct to which it belongs, and is aided by the current of blood in the left branch of the sinus portarum, setting across the mouth of the ductus venosus instead of plunging into it from the umbilical vein, as in fœtal life.

It is worthy of remark, that the left branch of the sinus portarum is bounded, on its right extremity, by the end of the vena portarum, and receives, about its middle, the umbilical vein. In the space, then, between the umbilical vein and the portal, the circulation, from the predominance of umbilical blood in fœtal life, is conducted from left to right, but afterwards from right to left, as the portal circulation is established and the other is arrested.

The Umbilical Arteries discharge the important office of conducting the effete blood of the fœtus to the placenta. They are the continuations of the internal iliacs, and are two in number, one on either side; they conduct off so much of the blood of the primitive iliacs, as to leave the external iliacs of a very small size. During the early months of uterine life, they are rather, indeed, the continued trunks of the primitive iliacs; the branches from the latter being then so little developed as to appear quite subordinate to the chief function, of carrying the blood out of the fœtus, to the placenta. But as the inferior extremities and the buttocks grow, these subordinate branches are more and more evolved.

At birth, the umbilical arteries, after dipping very superficially into the pelvis, rise up at the sides of the bladder and converge towards the navel. They emerge at the latter, cling together and traverse the umbilical chord by twisting spirally around the umbilical vein, like two small strings wound in this way upon a larger one. Their diameter is from a line to a line and a half. They anastomose as they join the placenta, but not previously.

Like the circulation between arteries and veins in other parts of the body, the capillaries of the umbilical arteries terminate in those of the umbilical vein in the placenta. From the observations of Wrisberg, Osiander and the venerable Professor Chapman of the University of Pennsylvania, it seems that there is no direct vascular communication between the mother and the fœtus.

This opinion is founded upon the leading facts, that the finest injections do not pass from one to the other; that fœtuses, after the death of

[1] Bichat, Anat. Descrip. vol. v. p. 419.

the mother from hemorrhage, still live and retain their usual quantity of blood; that, if the fœtus be expelled entire with the placenta and membranes unhurt, the circulation still continues. One example of which was witnessed nine minutes by Wrisberg;[1] another fifteen by Osiander;[2] some from ten to twenty minutes by Professor Chapman;[3] another for an hour by Professor Channing of Boston, and Dr. Selby of Tennessee;[4] where a bath of tepid water was used to resuscitate the fœtus. Also, from the observations of Breschet, it seems that the globules of the blood of the fœtus, when inspected by the microscope, are different in appearance from those of the mother.[5]

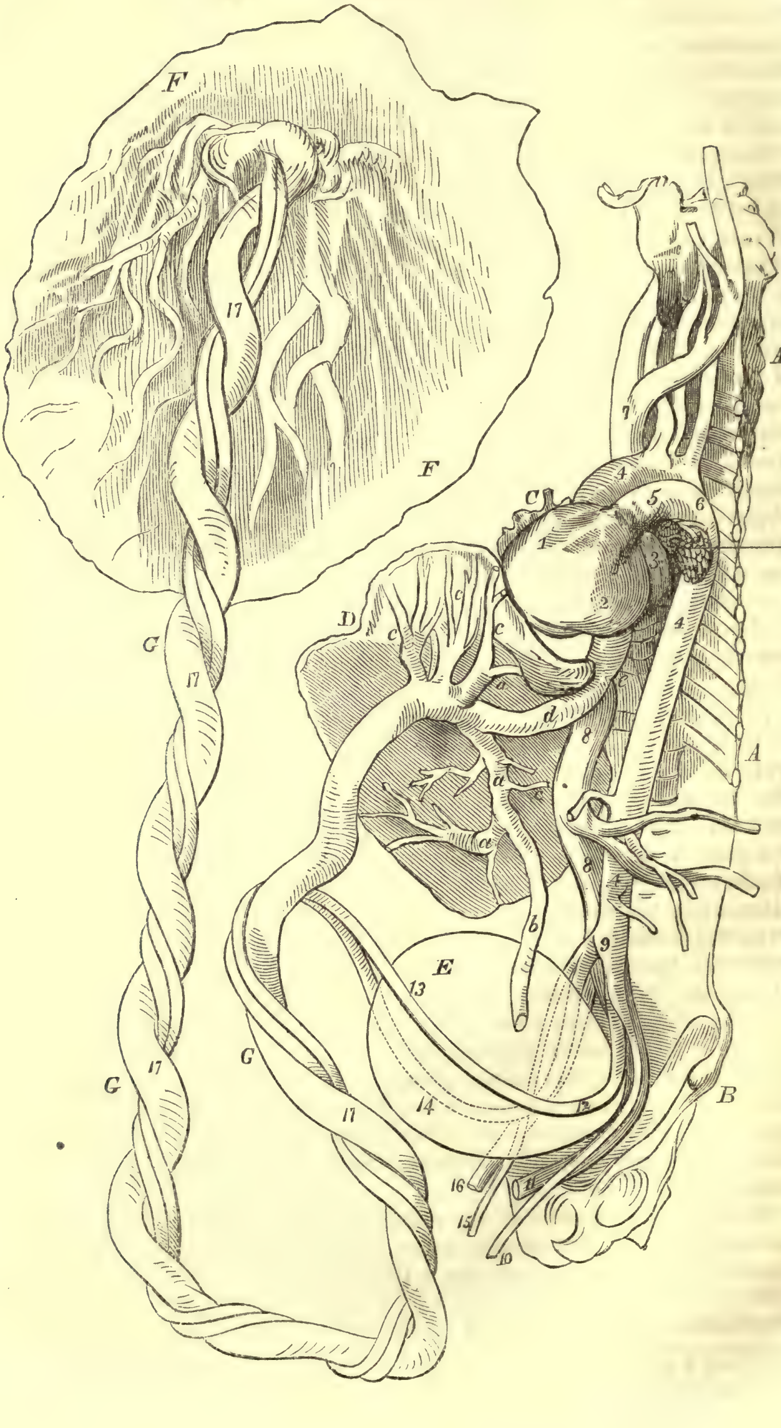
Mascagni says that he has made several most minute injections of the pregnant uterus, so as to cover with small vessels its whole internal surface, and to return the injection by the uterine veins: and yet he has never succeeded in injecting, in that way, the secundines.[6]

I have, myself, repeatedly tried by minute injection to pass articles from the fœtal into the maternal vessels, and the reverse, but always without success; in two instances, the experiment was upon human subjects, and, in the others, on the cow. In one of the latter, I perceived that some of the injecting matter thrown into the fœtal vessels had got into the uterine veins; but as the observation was in opposition to all the others, and solitary, I have no disposition to array it against them, at least until farther and more decided experience. My second experiment on the human subject was made in April, 1833, under the following circumstances. A white female, aged 24, died at the Almshouse, suddenly, and in the ninth month of pregnancy; the fœtus was still in utero, but the membranes were ruptured. In the presence of several of the physicians and students, and with the assistance of Dr. Goddard, to whose suggestions and manipulations I was indebted for the chemical compounds resorted to, I injected through the aorta one gallon of the saturated solution of Prussiate of potash, and followed it with an equal quantity of a saturated solution of sulphate of iron. The injection penetrated very minutely, as might be expected, and the precipitate of Prussian blue colored deeply many parts of the skin. On dissecting the uterus, the uterine arteries were found well injected, but the injection did not reach the umbilical vein or arteries, as was proved both by simple inspection and by chemical tests.

Having cut out the uterus and taken it to the University, the experiment was continued the next day in the presence of a large concourse of students and several physicians. The umbilical vessels were first of all injected with a saturated solution of bichromate of potash, and then with a saturated solution of sugar of lead. The result was a strong, yellow precipitate, the bichromate of lead. The injection passed reciprocally from the arteries into the vein, and from the vein into the arteries, conformably to the direction in which it was thrown for the time. The sinuses of the uterus were then injected with similar materials to those of the uterine arteries; to wit, a solution of Prussiate of potash, followed by one of sulphate of iron.

[1] Meckel, Man. D'Anat. vol. iii. p. 163.
[2] Id.
[3] Chapman's Med. and Phys. Journal, vol. i. p. 6.
[4] Id.
[5] Am. Med. Jour. vol. i. p. 193.
[6] Prodromo, vol. i. p. 127.

Fig. 252.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Fœtal Circulation, view on left side.—A, A. Spine and ribs. B. Pelvis. C. Heart. D. Liver. E. Bladder. F, F. Placenta with arteries and veins; it is represented under size. G, G, G. Umbilical cord.—1. Right ventricle. 2. Left ventricle. 3. Left auricle. 4, 4, 4. Aorta and branches. 5. Pulmonary artery at its root. 6. Ductus arteriosus from pulmonary artery to aorta. 7. Descending vena cava at junction of venæ innominatæ. 8, 8. Ascending vena cava. 9. Bifurcation of aorta into primitive iliacs. 10. External iliac artery, left side. 11. External iliac vein, left side. 12. Internal iliac artery, left side. 13. Umbilical artery, the continuation thereof. 14. Umbilical artery of right side dotted off to show its progress. 15. External iliac artery of right side dotted off. 16. External iliac vein of right side dotted off. 17, 17, 17, 17. The umbilical vein. It is entwined spirally by the two umbilical arteries. The arteries carry the blood to the placenta F, F, while the umbilical vein returns it to the fœtus. 18. Pulmonary vessels.—*a*, *a*, *a*. Sinus venæ portæ or portarum. *b*. Vena portæ, comparatively small at this period of life. *c*, *c*, *c*. Hepatic branches of vena portæ. *d*. Ductus venosus. *e*. Point of discharge of ductus venosus into the ascending cava.

The leading peculiarities of the fœtal circulation in the thorax are the foramen ovale, and the ductus arteriosus 5, 6. In the abdomen, the umbilical arteries 12, 13, 14, the umbilical vein 17, and the ductus venosus *d*, *e*.

The sinus portarum, *a*, *a*, *a*, differs much in shape from the adult; the middle, *a*, has the blood flowing from left to right in the fœtus, and from right to left in the adult, as it then comes from the vena portæ.

The umbilical vessels were then all filled with liquid plaster of Paris colored yellow: and the uterine sinuses with liquid plaster of Paris colored blue, of which they readily received eighteen ounces. A short time having been allowed for the setting of the injection, I cut into the substance of the uterus and of the placenta. No yellow injection was found in the vessels of the uterus, nor was there any blue injection found in the umbilical vessels of the placenta; there was, therefore, a deficiency of evidence of direct vascular communication between the fœtus and the mother. The placenta was infiltrated with Prussiate of iron, and considerable quantities of blue plaster were found in the cavity of the uterus.

In the progress of the injection with the Prussiate of iron, into the uterine sinuses, the membranes were raised from the uterus in vesications.

The parts, having been distended and put aside to dry, at the end of a fortnight they were examined again by incisions, and the same evidence of the want of direct vascular communication was renewed. But the placenta was found to be infiltrated according to certain rules seeming to depend on its organization. The blue coloring matter on the part of the uterus, and the yellow on the part of the fœtus, determined in it two parts, one uterine and the other fœtal, closely and alternately interlocked, like a dove-tailing: the uterine processes passed to within a short distance of the free surface of the placenta, while the fœtal processes went almost to the base of the placenta. The confines of the two colors were well defined by this abrupt termination of the borders of these dove-tails. The appearance would, perhaps, be better designated by the terms uterine lobes, and fœtal lobes, alternately penetrating, so as to constitute the whole mass of the placenta. No distinct vessel of a blue color could, however, be seen in the uterine lobes; but a few very spare yellow ones were visible. On raising up these uterine divisions, the orifices of the uterine sinuses were seen at their base.

The inference from this experiment is, that though there is no direct continuation of blood-vessels between the mother and the fœtus, yet there is a part of the placenta which seems to hold a special relation with the uterine sinuses, and which may possibly, therefore, by interstitial circulation, establish a connection with the fœtus. The facts are at any rate presented as they occurred.

The effete blood of the umbilical arteries becomes regenerated in the placenta, assumes a brighter hue, and is returned to the fœtus by the umbilical vein. According to the theory of Sabatier concerning the use of the Eustachian valve, if the latter did not exist, the fresh blood brought to the heart by the ductus venosus, instead of being diverted into the left auricle through the foramen ovale, would be received by the right auricle, and transmitted, either wholly or in a great degree, into the right ventricle. It would then be passed from the latter through the pulmonary artery and ductus arteriosus into the descending aorta, so that no part of the system, above the junction of the duct with the aorta, could receive the benefit of it; this would leave the head and upper extremities unsupplied with fresh blood. Moreover, much of the latter would be fruitlessly introduced, for it would depart almost immediately through the umbilical arteries. But the Eustachian valve determining the flow of blood of the ascending cava into the left auricle, its passage into the left ventricle is a matter of course: thence it begins the aortic circulation fairly, so that every part of the system participates in its benefit.

The celebrated Wistar[1] has also happily suggested that, without this arrangement, the blood of the coronary arteries of the heart itself, the purity of which is so essential to the vigor of circulation, would otherwise have been effete, and, consequently, unfit for its object of refreshing the heart.

The umbilical arteries become the round ligaments of the bladder, after the circulation through them has ceased, with the exception of their pelvic extremities, which subsequently constitute the trunks of the Internal Iliac Arteries.

CHAPTER V.

HISTOLOGY OF THE ABSORBENT SYSTEM.

The Absorbent System is one of the most interesting of those which compose the human body, both on account of its very general diffusion, and of the office of interstitial absorption that it incessantly carries on, thereby removing the effete parts of the body and making room for the deposit of new ones. It is also called the lymphatic system, owing to the transparent color of the fluid which it conducts.

With the exception of an imperfect observation of some of these vessels in the mesentery of a goat by Herophilus and Erasistratus during the reigns of the Ptolemies in Egypt, 280 years before Christ, what is known of them is entirely a modern acquisition in anatomy. In 1564, Eustachius discovered the thoracic duct of a horse, which, in

[1] System of Anat. vol. ii. p. 76, 3d edition.

the ignorance of its use, he called vena alba thoracis. This fact remained insulated and almost forgotten for seventy years. In 1622, Asellius discovered the absorbents of the mesentery, and in the discussions consequent thereto, the original observation of Herophilus and Erasistratus was revived from an oblivion of nineteen centuries, to be again brought to light and admired. Asellius seems to have understood that the absorbents of the mesentery collect the chyle from the intestines, but his knowledge ceased there, for he thought that they discharged into the vena portarum.[1] In 1634, Weslingius saw the thoracic duct again; and in 1649, ascertained that the chyliferous vessels of Asellius terminated in it. In 1650, Olaus Rudbeck, a young man pursuing his anatomical studies in Leyden, saw first the lymphatic vessels of the liver, and in a few months afterwards injected similar ones in the loins, in the thorax, in the groins, and in the arm-pits. Thomas Bartholine, a teacher of great reputation in those days, in a dissertation, dated in 1652, claimed for himself the priority of these observations, and from the obscurity of Rudbeck, enjoyed for some time the merit of them. In 1654, Rudbeck published and set forth his own pretensions with such force, that he finally triumphed over his antagonist, but not until the whole world of anatomy had been set in commotion; one party being for the professor, and the other for the pupil, and many bloody strifes having arisen between the students of the respective sides. In 1653, Jolyff, a celebrated anatomist of London, proclaimed his own rights to this warmly contested honor; but the period being rather late, his name is scarcely associated with the history of these feuds. Almost a century then passed before there were many important additions to the knowledge of those times. After which great contributions were made by Dr. A. Monro,[2] Dr. W. Hunter,[3] Hewson,[4] and Cruikshank,[5] but chiefly by the celebrated Mascagni,[6] who, having imagined finely pointed instruments of glass for executing his injections of these vessels, succeeded in demonstrating them in almost every part of the body, excepting the spinal marrow, the brain, the ball of the eye, and perhaps the placenta. In some of these parts, however, he says he has seen them, and he speaks confidently of their existence, without exception, everywhere, even in the enamel of the teeth.[7]

The Lymphatic Vessels are small, pellucid, transparent, cylindrical tubes, generally of about a line or less in diameter, whose trunks have been traced to all the external and internal surfaces of the body, and to the depth of all the organs, with the exceptions stated. It is only lately, however, that their existence on the external surface of the skin has been put beyond doubt, by the observations and injections of M.

[1] It is somewhat remarkable that the celebrated Harvey, who had himself so much to complain of, in the obstinacy with which his cotemporaries adhered to ancient errors, for thirty years resisted the discovery of Asellius, and finally died, protesting against it.
[2] De Venis Lymphat. Berlin, 1757–70.
[3] Med. Comment. London, 1762-77.
[4] Experimental Inquiries, London, 1774–77.
[5] Anat. of the Lymphatics, London, 1774–90.
[6] Vasor. Lymph. Corp. Hum. Historia et Ichnographia, Sienna, 1787.
[7] Prodromo della Grande Anatomia, vol. i. p. 1.

Lauth.[1] Their origin is so attenuated that anatomists have come to no satisfactory conclusion in regard to its manner.

The visible origin of the absorbents is, in some parts, as in the intestinal canal and on the glans penis, according to Breschet, a reticulated intertexture, the meshes of which are so close as to leave scarcely an interval between them. In the peritoneal coat of the liver this reticulation is so fine and close that the membrane appears to be composed wholly of them: their connection, however, with the deeper absorbents is so free that they cannot be preserved in this state, owing to the subsidence of the injection, especially if it be mercury. Professor Fohman, of Heidelberg, whose injections are said to be of a most superior kind, is of opinion that in many cases these vessels have a cellular origin, such at least is the appearance of those in the cornea and in the umbilical chord injected by him. Müller, however, doubts the accuracy of his conclusions in regard to the character of these cells.[2] Fohman is indeed of opinion that cellular substance consists merely of lymphatics.

The earlier cultivators of this branch of study, not knowing their absorbent properties, conceived them to be continuations of the arteriès applied to the reconducting of the serous part of the blood to the heart; and considered the opinion substantiated by the circumstance of their being occasionally filled by fine injections thrown into the arteries. More improved views of their uses caused the abandonment of this theory, and the substitution of their absorbing powers; in which case the minds of anatomists became divided between the ampulla-like mouth, or wide patulous origin of Lieberkühn, and the small orifices of Hewson.

It, is, perhaps, not possible to solve the question in regard to the mode of origin of the lymphatics, at least in most parts of the body. Meckel, about the middle of the last century, asserted their continuity with the veins. Mr. Ribes has seen matter injected into the vena portarum find its way into the lymphatics of the liver. On this subject, M. Chaussier says[3] that, ignorant of the manner in which the arteries, veins, nerves, and lymphatics arrange themselves collectively into a glandular structure, or, in other words, into a capillary system, we cannot avoid ignorance of the part acted by the lymphatics alone; we only know that the minute lymphatics form a portion of the elements of each viscus and structure of the body, and that they only become visible in becoming larger trunks.

The absorbents, in proceeding from their origins, in general become larger and less numerous, and form frequent anastomoses with one another. The proportionate increase of magnitude from the successive junction of trunks is by no means equal to what occurs in the veins. The larger superficial absorbent trunks of the extremities have not so much disposition to run into one another, hence they retain a size almost uniform from one end of the limb to the other. When fully distended, the appearance of absorbents is not regularly cylindrical, but knotted, owing to the frequent valvular interruptions in their

[1] Essai sur les Vaisseaux Lymph. Strasburg, 1824.

[2] Loc. cit. p. 283.

[3] Dict. des Sciences Méd. Art. Lymphatiques.

cavities. The absorbents from all parts of the body are finally united into two tubes; one on the left, and the other on the right side of the trunk of the body, which discharge their contents into the venous system, each on its respective side, at the junction of the internal jugular and the subclavian vein. The trunk on the right side receives the lymphatics of the right side of the head and neck, of the right lung, and right superior extremity; while the trunk on the left, called the thoracic duct, receives all the chyliferous vessels and the lymphatics of the remaining part of the body. It would appear, from the observations of the younger Lauth,[1] that there are also other terminations of the lymphatics in the veins; to wit, such as in the yet capillary state end in the veins of the minute structure of organs, and such as empty into them in the interior of the lymphatic glands. Previously to Lauth, this sentiment of communication with the veins was strongly advocated by several anatomists and physiologists, for the following reasons: 1. That the known roots of the lymphatic system have an area much superior to that of the trunks in which they terminate. 2. That substances introduced into certain lymphatics by absorption or injection have been found in the contiguous veins. 3. That a ligature upon the thoracic duct produced death only after ten or fifteen days, and then the articles which had been absorbed by the intestines, were found in the blood. 4. And that injections had proved this communication.

Notwithstanding the well-known fact of injections, under certain circumstances, passing from the arteries into the lymphatics, some anatomists of modern date have hesitated in admitting a direct communication. M. Meckel has, indeed, rejected the notion entirely, on the ground that the fluid contained in the trunks of the absorbents is always the same as one finds at their commencement. For example, the lymphatics coming from the liver contain a fluid like bile; those which come from the mammæ contain a fluid like milk; those which come from parts suffering from an extravasation of blood contain a sanguineous fluid; the bronchial glands are colored by the black pigment brought to them from the lungs; poisonous matter, as that of the small-pox or venereal, irritates and inflames the lymphatics that lie in the course of its introduction into the system. For these reasons it would appear to him that the arteries do not continue themselves into the lymphatics as they do into the veins. The observations of M. Lauth seem to have proved the point, that some of the lymphatics take their origin from the internal surface of the arteries; and it may be through them that injections have been forced from one system into the other.

The coats of the lymphatics generally are too thin and transparent for an investigation of their structure; but as those of the thoracic duct are sufficiently thick for the purpose, one may estimate the structure of other trunks by it. It is thus ascertained that they consist of two coats, an internal and an external one.[2]

[1] Loc. cit.

[2] Valentin asserts that there is also a middle coat, and Henle that there is an internal epithelium.

The external coat is somewhat irregular on its surface, from its connection with the adjacent cellular substance; and has a filamentous appearance more deeply, which has been considered as fibrous, or muscular, by some anatomists, owing to its contraction upon the application of certain stimulants. The internal membrane is extremely fine and perfectly transparent, and is remarkable for its frequent duplications, whereby a system of valves is produced resembling those of the veins. These valves are generally of a semilunar or parabolic shape, and are arranged in pairs, though, according to Lauth,[1] some of them are circular, and do not close the canal entirely. The pairs are not placed at stated distances from one another, but vary in different parts of the body; in some places there are several in the course of an inch, and in others not one pair. As a general rule, they are less frequent as the trunk increases in magnitude; hence, the thoracic duct has but very few of them. The valves, by having their semi-circumference fixed, while the diameter is loose and inclined in the course of the circulation, prevent the retrograde movement of the contained fluid. An enlargement of the trunk at their outer face into sinuses, resembling those at the valves of the veins, gives also to the lymphatic trunk a knotted condition when it is fully injected.

The coats of the lymphatic vessels, though very thin, are yet dense and extremely strong, much more in proportion than those of any other tubes. They are both extensible and elastic, possess striking powers of spontaneous contraction in the living body, and also contract in the dead, but to a less extent. They are furnished with arteries and veins, and probably with nerves also, from their sensibility in a state of inflammation. And, as they stand in need of a similar organization with other canals, their parietes are said also to have lymphatics.

The absorbent vessels are, by some, divided into lacteals and lymphatics,[2] the first term expressing those which convey the chyle from the intestines, and the second such as are found in other parts of the system. As the difference is more in the fluid conducted than in the structure of the vessels themselves, the division is rather superfluous. There is also a distinction of the lymphatics, as in the veins, arising from their situation; some of them are called superficial, and the others deep-seated. The arrangement upon which this nomenclature depends is found in the head, trunk, extremities, and in most of the viscera. The deep-seated trunks are the largest. They are the least numerous in the muscular parts of the body.

Of the Lymphatic Glands.

The Lymphatic or Absorbent Glands or Ganglions, sometimes called waxen kernels in common language, are an appendage of a very im-

[1] Loc. cit.

[2] This division has been handed down from the time of Bartholine, who, not suspecting the absorbing powers of the lymphatics, held them only as organs of circulation for restoring to the heart the serum of the blood. The sagacious mind of Dr. W. Hunter first imagined their absorbing powers, and established the theory of their identity of function, in this respect, with the lacteals. The priority of the theory was warmly contested for Dr. Monro, of Edinburgh.

portant description to the absorbent system. They are flattened ovoidal bodies, of a reddish ash color, indurated so as to afford a strong resistance to pressure, and of a variable volume, from a line to twelve lines in their long diameter. They are found principally in clusters or chains, and are more abundant in the neck, in the groin, in the arm-pit, in the mesentery, and about the bifurcation of the trachea.

The lymphatic vessels, in their course towards the thoracic duct, have to pass through one or more of these glands. This rule is almost universal; some exceptions, however, to it, in the case of the lower extremities, have been stated by Mr. Hewson, and in the case of the back, by Mr. Cruikshank:[1] the latter believes Mr. H. to have been under a misapprehension in this statement concerning the extremities, as it had not been verified by the result of his own investigations. The vessels that enter into the glands are called vasa inferentia, while those that depart from them are the vasa efferentia. As, owing to the juxtaposition of many of these glands, the vessels between them are very short, this distinction would seem to be almost superfluous, because there is scarcely space to apply the term efferentia, before the same vessels enter the consecutive gland, thereby becoming inferentia. For the most part, the vasa inferentia are more numerous and somewhat smaller than the efferentia. The former, as they enter the gland, radiate into smaller branches, while the latter are formed from the junction of smaller branches.

Each lymphatic gland is surrounded by a capsule, resembling condensed cellular substance, which adheres very closely to the gland, and from which cause many anatomists are disposed to deny its existence, at least as a distinct membrane. They are also abundantly furnished with arteries and with veins destitute of valves; but though they are penetrated by nervous filaments, it is not yet satisfactorily ascertained that any remain with them; it is, however, more probable than otherwise. Their connection with the surrounding cellular substance is sufficiently loose to permit them, in certain parts, to be slid moderately backwards and forwards. When this motion is arrested, it is from inflammation about them.

The capsule of the lymphatic gland, like that of other glands, sends processes within to keep its parts together, and to conduct the blood-vessels. It also contains a peculiar fluid called, by Haller, succus proprius, which is principally found in young animals, diminishes as they advance in age, and finally disappears. It is of various colors, but more frequently white; it appears to have globular particles in it, which the late Mr. Hewson, for divers reasons, thought to become afterwards the red globules of blood.

When a lymphatic gland is injected with quicksilver, it appears to be made up by the minute branching of the vasa inferentia, and the roots of the vasa efferentia, the former being continued into the latter. There is also some appearance of small cells intermediate to these two orders of vessels. All anatomists admit the former opinion; but many reject the latter, under a presumption that the appearance is delusive.

[1] Anat. of Absorb. Vessels, second edit. p. 79, London, 1790.

The arguments seem to be in favor of their existence. Mr. Cruikshank,[1] whose address in these matters was certainly of the first order, declares that he never failed to perceive them, and particularly well, just as the mercury was entering the gland. This arrangement is still more readily made out in animals, as the horse, ass, mule. It also seems, from his observations, that when there are more than one vas inferens and efferens, there are cells for each set, which are kept distinct from the cells of the others, though they communicate freely with their cognates. Mr. Abernethy's investigations, on the mesenteric glands of whales, coincide with the views of Mr. Cruikshank: he states, indeed, the cells as being large spherical bags, into which the lacteals plainly open. The celebrated Mascagni also acknowledges, and, in fact, describes the cellular structure of these glands,[2] which he had ascertained both by quicksilver and by wax injections. The improved notions of modern anatomy, upon what is called the erectile tissue, that is, the cells intermediate to arteries and veins, as in the penis and other places, and now considered rather as the dilated extremities of vessels, would also assist in warranting the opinion advocated. The celebrated Ruysch thought that he had discovered acini in the lymphatic glands, and sent his injected preparations illustrative of them to Boerhaave. Some idea of the enthusiasm of the anatomists of old may be conceived by his saying "Quando jam clarius et perfectius videbam hæc omnia, præ gaudio exsiliebam."

When the absorbing powers of the lymphatics had been established by Dr. W. Hunter, they were for a long time considered as the exclusive functionaries in this operation; and the opinions previously entertained had sunk into such disrepute, from some experiments of Mr. John Hunter,[3] that they were considered rather as food for literary research and curiosity than for deliberate adoption. In the year 1809, M. Magendie reported his experiments on absorption, which seemed to favor the notion that the veins also assisted in this office, a theory as ancient as Galen. The more recent observations of Fohman, in 1821, and Lauth, in 1824, on the communications of the lymphatics with the veins, in the midst of the tissues of organs, and in the lymphatic glands, seem now to explain away again the theories of the absorbing powers of the veins, and to reinstate the lymphatics in their reputed exclusive functions. It is also stated that an anatomist of Florence, M. Lippi, has still more lately found several large lymphatic trunks entering into the ascending cava. The connection of the lymphatic system with the vena cava ascendens, and also with the external iliac veins, has been farther demonstrated by certain preparations, exhibited by M. Amussat to the Académie Royale.[4] M. Fodera has, however, again brought the subject under discussion, by multiplying the active agents of this function, and says that his experiments prove that all organized tissues enjoy it, and not certain parts only, as has been here-

[1] Loc. cit. p. 15, pl. iii.
[2] Vasor. Lymph. Hist.
[3] Med. Commentaries.
[4] Am. Med. Journ. vol. i. p. 422.

tofore supposed;[1] from which it results that most of the rules in regard to the application of local remedies are inexact, and that we should have more regard to the thickness and density of tissues, to the quantity and rapidity of their circulation, than to simple locality.[2]

CHAPTER VI.

OF THE SPECIAL ANATOMY OF THE ABSORBENT SYSTEM.

SECT. I.—OF THE ABSORBENTS OF THE HEAD AND NECK.

THE Superficial Absorbents of the head are found in company with the several branches of the temporal, the occipital, the frontal, and the facial arteries, and, in order to get into the lymphatic trunks leading to the thoracic duct, follow or rather reverse the course of their respective arteries. There are at least two absorbent trunks for one arterial, and frequently more: those on the face are more abundant than such as are on the side of the cranium, owing to the excess of cellular substance on the former. The absorbents of these two regions anastomose freely beneath the external ear, between the skin and the parotid gland.

The Deep-Seated Absorbents of the head have been followed to the membranes of the brain, but not farther. Ruysch observed them between the tunica arachnoidea and the pia mater, inflated with air, and called them vasa pseudo-lymphatica. Lancisius, Pacchioni, and others assert their having found them in the pia mater. Doubts are cast upon these several observations, owing to such vessels not having been injected with quicksilver, and from the want of a valvular appearance in them; also from the want of lymphatic glands in the cavity for the brain. Their existence would seem to be sufficiently proved, both from general analogy, and from affections of the brain producing swellings in the glands of the neck. On the dura mater they have been traced along the course of its arteries. They descend from the interior of the cranium into the neck, along the carotid and vertebral arteries. The absence of lymphatic glands in the cranium may be accounted for from the fact that the ready tendency of these organs to swell upon slight causes of irritation would have rendered the individual liable to death from compression of the brain, by their tumefaction. Mr. Cruikshank considers himself to have found lymphatic glands in the carotid canal.

The Deep Lymphatics of the face, as those from the interior of the

[1] Recherches Experimentales sur l'Absorption et l'Exhalation, Paris, 1824.

[2] For a most interesting and instructive series of experiments on the laws and phenomena of absorption, see *Philadelphia Journal of the Medical and Physical Sciences*, Nos. 6 and 10. The experiments were executed by Drs. Jason, O. B. Lawrence, Benj. H. Coates, and Richard Harlan, of this city.

nose, of the orbit of the tongue and mouth, attend the arteries which respectively supply those parts.

These several absorbents, from the surface and from the interior of the head, descend to the base of the cranium, and then begin to pass through the chain of lymphatic glands situated along the course of the great blood-vessels of the neck. They lie, for the most part, under the sterno-mastoid muscle, and, when successfully injected, are thought to form the most brilliant plexus of absorbents in the whole frame. On each side of the neck, one or more common trunks are, at length, formed; that on the left side joins the Left Thoracic Duct near its termination, while the one on the right assists in forming the duct peculiar to that side, the Right Thoracic Duct, or, more properly called, the Right Brachio-Cephalic.

The lymphatic vessels of the muscles of the neck, and those of the thyroid gland, enter into the trunks of the neck. According to Mr. Cruikshank, those of the thyroid gland may be readily injected by plunging a lancet at random into its substance, and then introducing air or quicksilver.

Of the Absorbent Glands of the Head and Neck.

The only claim of lymphatic glands to an existence in the cavity of the cranium is founded upon the supposition that the Pineal, the Pituitary, and Pacchioni's Glands are of this character; but it is far from being established, and there seems indeed to be some doubt whether the glands found in the carotid canal, by Mr. Cruikshank, are not the carotid ganglion of the Sympathetic, noticed by Laumonier.

On the external surface of the cranium, over the insertion of the sterno-mastoid muscle, there are from four to six of a small volume; on the face there is one or more small ones, below the zygoma, and from two to four on the external surface of the parotid; there is one or more small ones situated in the substance of the parotid gland, which, according to Burns, are generally the seat of tumors falsely attributed to the parotid itself. There are also some small glands along the facial artery as it ascends from the base of the jaw to the corner of the mouth.

On the neck there are two or more small glands, immediately under the skin of the symphysis of the jaw, and eight or nine around the submaxillary gland. The most numerous congeries of glands on the neck is along its great blood-vessels, and covered more or less by the sterno-mastoid muscle, being principally between its posterior margin and the anterior of the trapezius. Along the latter line there are about twenty, in addition to six just above the superior margin of the clavicle. On the trachea just above the sternum, there are four, forming the upper end of a series which descends along the œsophagus and trachea to the root of the lungs.

SECT. II.—OF THE ABSORBENTS OF THE UPPER EXTREMITIES AND OF THE CONTIGUOUS PARTS OF THE TRUNK OF THE BODY.

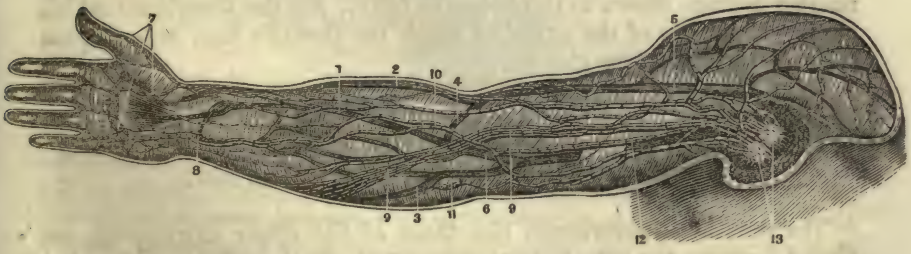
The superficial absorbents of the upper extremities are very numerous, and lie between the skin and aponeurosis. They begin at the ends of the fingers and thumb; there being two or more branches for each, both before and behind. The posterior branches pass to the back of the hand and of the fore arm: some of them, more especially those from about the thumb, run up along the radial side of the fore arm to the bend of the arm; but by far the greater part of them incline very gradually in a semi-spiral manner towards the ulna, and then to the front of the fore arm.

Such of the superficial vessels as come from the front of the fingers and hand, continue to ascend straight up the fore arm to its bend. These vessels of the fore arm are so numerous that for every few lines there is an ascending trunk on its circumference: some of them coalesce, others form plexuses, and their number is much reduced at the elbow.

From the elbow the superficial lymphatics ascend to the axilla in fifteen or twenty parallel trunks, along the internal margin and the front surface of the biceps flexor cubiti. The outer side of the arm has comparatively but few absorbent trunks upon it; but some follow the course of the cephalic vein, penetrate with it into the axilla, and then join the inferior lymphatics of the neck.

The Deep Absorbents of the upper extremity attend the arteries, and are at least two for each principal artery. They anastomose with the superficial ones at intervals, and at last terminate in the axillary glands. As they follow strictly the course of the arteries, a farther specification is needless.

Fig. 253.



The Superficial Lymphatic Vessels of the Upper Extremity.—1. Median vein. 2. Cephalic vein. 3. Posterior basilic vein. 4. Median cephalic. 5. Cephalic vein high up the arm. 6. Median basilic vein. 7. Superficial lymphatics of the hand. 8. Lymphatic trunks from the inside of the hand. 9, 9. Principal fasciculus of lymphatics from the front and back of the fore arm. 10. A branch from the superficial to the deep lymphatics of the fore arm. 11. A lymphatic gland. 12. Superficial lymphatics which dip down with the basilic vein. 13. The lymphatic glands of the axilla, which receive the lymphatic vessels of the arm.

The Superficial Absorbents of the contiguous portions of the trunk of the body are not by any means so numerous as those of the upper extremity; they consequently are more distant from one another, and they also go along in a more serpentine manner. From the nape of

the neck to the lower part of the loins they all converge to the arm-pit. The absorbents which are situated on the front of the pectoralis major muscle, and those on the side of the body from the arm-pit to the hip, also converge to the axilla. In regard to the two latter places, some of their absorbents, by penetrating the parietes of the thorax or abdomen, respectively join the internal absorbent trunk of these cavities.

These several lymphatics from the upper extremity and from the trunk, traverse the axillary glands, and are successively reduced in number to four or five voluminous trunks, which surround the subclavian artery. While in the axilla they are reinforced by the deep lymphatics from beneath the pectoralis major, the latissimus dorsi, and the shoulder. Their number being again reduced, they go along the subclavian vein over the first rib; those of the left side open either into the thoracic duct at its termination, or into the subclavian vein near it: but those on the right are finally assembled into the single large trunk, brachio-cephalic, which discharges into the angle of junction of the right internal jugular and subclavian vein.

Absorbent Glands of the Upper Extremity.

These glands are rarely found on the fore arm, but when they do exist, it is in the course of the deep absorbents, and they are very small, and but few. From one to four are found scattered on the front of the elbow and internal condyle. From four to seven exist along the sheath of the brachial vessels and nerves.

The axillary glands are very numerous, and of different sizes; they are dispersed throughout the cellular substance of the axilla, reposing on the serratus major anticus, between the pectoral muscles, and those of the shoulder, and being for the most part below the axillary vessels and nerves, but some reposing immediately upon them, and forming a chain from the lower part of the axilla to the clavicle. Their number is from fifteen to thirty-five or forty. All the absorbents which observe the route of the axilla to reach the thoracic duct have to pass through some of these glands.

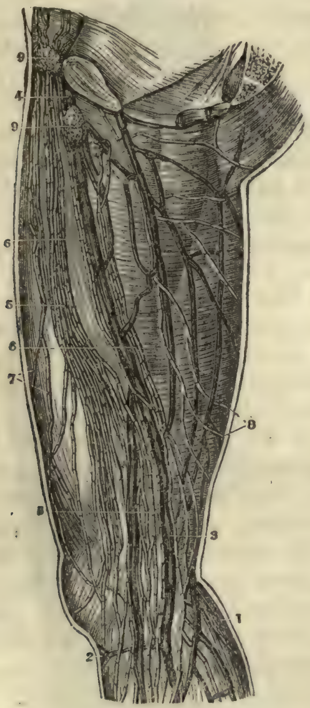
SECT. III.—ABSORBENTS OF THE INFERIOR EXTREMITIES AND OF THE CONTIGUOUS PARTS OF THE TRUNK OF THE BODY.

The superficial absorbents, like those of the upper extremities, are placed between the skin and the aponeurosis, in the cellular tissue that contains the subcutaneous veins. They are also very abundant, and are found every few lines on the circumference of the limb; they are, however, more numerous internally than externally, and, for the most part, run upwards.

Those on the inner or anterior side of the limb are first perceived on the back of the toes and foot. They incline over the front of the ankle, and its internal face, to the inner side of the leg; they then ascend over the inner side of the knee, and along the same side of the thigh

to the groin. The superficial absorbents of the back of the lower extremity are first perceived on the sole of the foot. They ascend along the back of the outer ankle and of the leg above the knee; they then incline semi-spirally inwards, so as to bring themselves to the front of the thigh. These several absorbents, though there are but few on the foot, augment continually in number by new accessions in their ascent. All those on the posterior internal face of the thigh wind over its internal side, while such as are on its posterior external face wind over the outer side, to reach the inguinal glands.

Fig. 254.



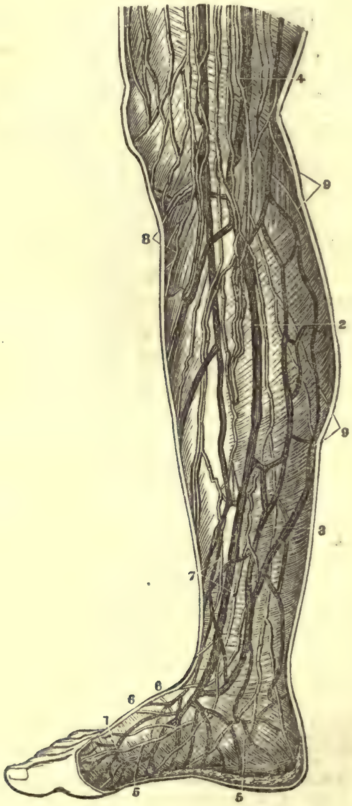
A view of the Superficial Lymphatics of the Thigh.—1. The external or saphena minor vein. 2. The venous anastomosis below the patella. 3. Femoral portion of the saphena major. 4. Point where it enters the femoral vein. 5. The great chain of superficial lymphatics on the inner side of the thigh. 6, 6. A chain of three or four parallel trunks, which accompany the saphena major vein. 7. Branches from the front of the thigh. 8. Branches from the posterior part. 9, 9. The inguinal glands into which the superficial lymphatics of the lower extremity enter.

The Deep Absorbents adhere to the arteries, being at least two to each, and adopting the same distribution and nomenclature. The anterior tibial set begins in the sole of the foot, and rises to its back between the first two metatarsal bones; another branch begins on the dorsum of the foot. The first pursues the course of the anterior tibial artery through the interosseal ligament to the ham; the second frequently joins the peroneal absorbents about half way up the leg. The posterior tibial and the peroneal absorbents, as they cruise along their respective arteries, do not require any farther comment. There is a fourth set of these deep absorbents, amounting to two or three in

number, which attend the external saphena vein, and come from the external side of the foot. Getting between the heads of the gastrocnemii muscles, they are reinforced by other trunks from this muscle; some of the branches then associate themselves with the superficial lymphatics, and others penetrate the ham, so as to join the deep trunks there.

The deep absorbents of the leg coalesce partially in the ham, and ascend along the popliteal artery. On the thigh, there are from four to eight of these trunks attending the femoral artery, and receiving additions as the latter detaches branches.

Fig. 255.



The Superficial Lymphatics of the inner side of the Foot and Leg.—1. The venous anastomosis on the phalangial ends of the metatarsal bones. 2. The saphena magna vein. 3. Lymphatics on the back of the leg. 4. The same vessels on the lower part of the thigh. 5, 5. Lymphatics coming from the sole of the foot. 6, 6. Lymphatics from the dorsal surface of the foot. 7. The lymphatics which accompany the saphena vein. 8. Branches of lymphatics from the front and outside of the leg. 9. Branches from the posterior and internal side of the calf of the leg.

There are two or three lymphatic vessels on each side of the penis, which begin at its glans and prepuce, and traversing the length of this organ, wind above the external abdominal ring to join the nearest inguinal gland. There are several from the side of the scrotum and perineum, which ascend along the chord and thigh to join also the nearest inguinal gland. In the female, those of the labia externa and clitoris correspond with those of the scrotum and penis.

The superficial absorbent trunks, from the lower front of the abdomen, are not numerous; they descend and converge also to the inguinal glands. Some of those from the loins, such as do not ascend to the axilla, advance to the inguinal glands. Those of the buttocks do the same.

Absorbent Glands of the Lower Extremities.

Absorbent Glands, below the knee, are not abundant, or indeed, very common; yet one or two exist sometimes in the course of the anterior tibial artery, in the upper part of the leg. The popliteal glands are three or four; they are small, and scattered at wide intervals in the fat of the ham around its vessels. From the latter to the groin, glands are not usually found at all.

The inguinal glands are amongst the largest in the system; they repose along the anterior margin of Poupart's ligament and a little below, and are readily felt beneath the skin. The superficial vary in number, in different individuals, from seven to twenty, being more numerous as they are smaller, and are placed between the laminæ of the fascia superficialis. They receive, first of all, the superficial lymphatics of all the parts mentioned. The deep-seated are smaller, are a little lower down on the thigh, and lie along the course of the femoral artery, beneath the aponeurosis of the thigh; they are from three to seven in number, but are much less constant than the superficial.

SECT. IV.—DEEP ABSORBENTS OF THE PELVIS.

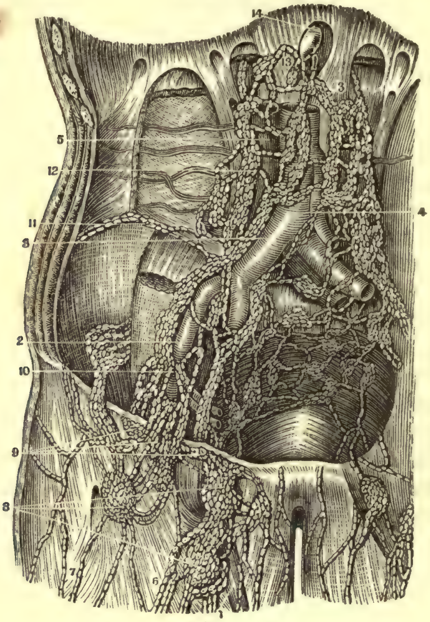
The Deep Absorbents of the parietes of the pelvis, as in other cases, attend the arteries of the part and have the same names. The obturators come from the heads of the adductor muscles, and passing through the obturator foramen, end in the hypogastric glands. The ischiatics come from the small muscles on the back of the hip joint, and, getting into the pelvis along with the ischiatic artery, they also terminate in the hypogastric glands. The gluteals come from the three gluteal muscles, and entering the pelvis along with the artery at the superior margin of the sciatic notch, they likewise terminate in the hypogastric glands along with some vessels from the anus and the perineum. The ileo-lumbar, the sacral, and the circumflex iliac absorbents also follow their respective arteries and terminate in the nearest glands.

The absorbents of the Testicle are numerous and large: according to Dr. W. Hunter,[1] they can sometimes be very completely injected by a pipe thrust into the substance of the testicle; and according to Cruikshank,[2] very advantageously from the vas deferens, which has succeeded in my own hands. They form two layers, one superficial coming from the tunica vaginalis testis, and the other from the substance of the gland. They finally unite into some six or eight trunks, which[3] ascend with the chord through the abdominal canal. Occasionally one or more of them

[1] Loc. cit. [2] Loc. cit. p. 155. [3] Mascagni, loc. cit.

is as large as a crow's quill. By following the course of the spermatic artery, they at last terminate in the lumbar glands.

Fig. 256.



A front view of the Femoral, Iliac, and Aortic Lymphatic Vessels and Glands.—1. Saphena magna vein. 2. External iliac artery and vein. 3. Primitive iliac artery and vein. 4. The aorta. 5. Ascending vena cava. 6, 7. Lymphatics which are alongside of the saphena vein on the thigh. 8. Lower set of inguinal lymphatic glands which receive these vessels. 9. Superior set of inguinal lymphatic glands which receive these vessels. 10. The chain of lymphatics in front of the external iliac vessels. 11. Lymphatics which accompany the circumflex iliac vessels. 12. Lumbar and aortic lymphatics. 13. Afferent trunks of the lumbar glands, forming the origin of the thoracic duct. 14. Thoracic duct at its commencement.

The deep absorbents of the Penis accompany the arteries, and, therefore, either get into the pelvis beneath the symphysis of the pubes, or along the crura and the tuberosities of the ischia; hence, a chancre on the prepuce causes bubo, while one on the glans very rarely does, and yet the constitution will be equally affected.[1] These absorbents terminate in the hypogastric glands.

The deep absorbents of the Clitoris follow, in the same way, the internal pudic artery.

The absorbents of the Urinary Bladder are also numerous, and pass in several trunks from its sides to the hypogastric glands. Those of the prostate gland and vesiculæ seminales are associated with them.

The absorbents of the lower part of the vagina accompany the round ligament of the uterus through the abdominal canal, and finally anastomose with those of the uterus. Those of the upper portion of the vagina are immediately associated with such as belong to the uterus.

The absorbents of the uterus are not so well seen in the unimpregnated state, but in impregnation they are so prodigiously numerous that,

[1] Cruikshank, loc. cit.

when injected with quicksilver, one is almost tempted to suppose that the uterus consists entirely of them. Mascagni's plate on this subject is an exquisite specimen.[1] As they all terminate in the hypogastric trunks, the latter are in such case as large as goosequills.[2]

The hypogastric plexus, from these several accessions from the parietes and viscera of the pelvis, becomes very large, and follows the course of the hypogastric artery in ascending into the loins.

There are likewise some spermatic absorbents in the female, called so from attending the vessels of the same name. They come from the ovarium, the Fallopian tube, and the round ligament, to terminate in the lumbar glands: they anastomose below with those of the uterus.

Of the Glands of the Pelvis.

Some few glands lie beneath the gluteus magnus muscle, but the majority are within the pelvis. Those which are called the External Iliac are at least six, frequently more, and extend from Poupart's Ligament to the lower part of the loins, being planted along the external iliac artery, both above and below. The Hypogastric or Internal Iliac Glands are rather more numerous than the others, and form a chain along the hypogastric artery. They are much disposed to form large indurated masses from diseases of the rectum, uterus, and bladder.[3]

SECT. V.—ABSORBENTS OF THE ORGANS OF DIGESTION.

The Absorbents of the Stomach are very numerous, and lie in two planes: one is superficial, being immediately beneath the peritoneal coat, and the other is profound, being placed between the muscular and the mucous coat. They are, finally, assembled into three divisions, which follow the course of the principal blood-vessels of this organ.

One division, coming from the anterior and the posterior face of the stomach, converges to its lesser curvature, and passes through some six or eight small glands in the adjacent portion of the lesser omentum. Inclining to the right of the cardiac orifice, its trunks then pass through some glands common to them and to the deep lymphatics of the liver. Their numbers being reduced, they then descend behind the pancreas, and terminate in the thoracic duct near the cœliac artery.

The second division comes from the left inferior portion of the stomach, and from its greater extremity, and, blending with the absorbents of the spleen and pancreas, goes with them into the thoracic duct.

The third division comes from the right inferior portion of the stomach, and, assembling towards the pylorus, is subsequently mixed with some of the absorbents of the liver and of the small intestines, and goes along with them into the thoracic duct.

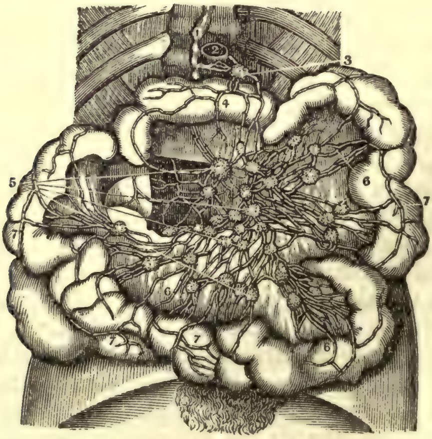
The Absorbents of the Great Omentum join those of the stomach and of the colon, at the points most convenient to them.

[1] Cruikshank, loc. cit. [2] Ibid. [3] Ibid.

The Absorbents of the Small Intestines, like those of the stomach, are both superficial and deep, and from the function of conveying chyle, have been called lacteals, or chyliferous vessels. As the chyle, however, can only be absorbed by the deep ones; as they and the superficial have common trunks; and as they also absorb, from the intestines, fluids not converted into chyle, there seems to be no necessity for distinguishing them by a particular epithet. The deep are in the cellular coat of the intestine, and follow the ramifications of the arteries, being double their number. The superficial, being immediately beneath the peritoneal coat, run for some distance, longitudinally, on the gut, and then turn off to the mesentery at right angles.

On the mesentery these absorbents are not rigidly bound to the course of the blood-vessels; they converge in a slightly tortuous manner from its circumference to its root. They anastomose with one another, by which their number is reduced; and they also have to pass through the series of mesenteric glands. The lacteals of the duodenum and jejunum are larger and more numerous than those of the ileum, in the proportion of the greater extent of the internal surface of the former intestines, from the number of their valvulæ conniventes. The vessels of the mesentery, after having cleared the series of glands, and held some intercourse with the lymphatics of the spleen, liver, stomach, and pancreas, are reduced at last into one or more large trunks, which, observing the course of the superior mesenteric artery, empty near the root of the latter, but sometimes lower down, into the thoracic duct.

Fig. 257.



A view of the Lymphatics of the Small Intestines of a man dead from ascites.—1. Thoracic duct. 2. Section of the aorta. 3. Glands around the aorta which receive the lymphatics from the intestine and give off vessels to the thoracic duct. 4. Superficial lymphatics on the intestine. 5, 5. More lymphatic glands receiving vessels from the intestine. 6, 7. Lymphatics of the intestine and mesentery.

The Absorbents of the Large Intestines are much less numerous than those of the small. They are also superficial and deep, and observe the course of the blood-vessels. Those from the right portion and middle

of the colon join the lacteals of the mesentery, while such as belong to the sigmoid flexure follow the inferior mesenteric artery up to the lumbar glands. Those of the rectum go partly into the lumbar and partly into the hypogastric glands, and as its blood-vessels are more numerous than those of other portions of the large intestine, its absorbents are in the same proportion.[1]

The Absorbents of the Liver are exceedingly numerous, and are also injected with unusual ease from the larger into the smaller trunks, from the imperfection of the valvular arrangements. They are also superficial and deep.

The Superficial Absorbents of the upper surface of the liver run in several divisions, the number of which is unsettled. Those near the middle front of the liver assemble into six or more trunks, which ascend the suspensory ligament, and enter the thorax between the diaphragm and the sternum. They are joined by several trunks from the diaphragm, and, continuing to ascend up the anterior mediastinum between its laminæ behind the sternum, they are reinforced by contributions from the pericardium, from the thymus gland, and from the anterior parietes of the thorax. The division then crosses the upper end of the descending cava, and those from the two sides assembling, they go in one or more large trunks along the left vena innominata, and finally empty into the left thoracic duct near its termination. Sometimes they enter into the right thoracic duct. It occasionally happens that a detachment of this division, instead of ascending through the mediastinum, is directed towards the coronary ligament of the liver; and being there joined by other vessels, it enters immediately into the thoracic duct at the upper part of the abdominal cavity, or at the lower part of the thorax.

Another division comes from the upper surface of the right lobe, and gaining the right lateral ligament, penetrates into the thorax through the diaphragm, and, advancing along the costal margin of this muscle, terminates in the first division under the sternum. Sometimes one of its branches, thrice as large as a crow's quill, runs backward to the spine, and is inserted into the thoracic duct behind the œsophagus, without passing through any gland; there are also, occasionally, several other arrangements of the trunks of this division.[2]

Another division comes from the upper surface of the left lobe of the liver; and its trunks advancing to the left lateral ligament, get into the thorax through the diaphragm. Some of the trunks then run forward on the convexity of this muscle, to terminate in the trunks under the sternum, while others retire backward to end in the glands around the œsophagus, immediately above the diaphragm.

There are various departures from this general arrangement of the absorbents on the upper surface of the liver; as their trunks invariably reach the thoracic duct ultimately, the particular routes do not seem to be rigidly fixed.

[1] Cruikshank, loc. cit. [2] Ibid.

The Superficial Absorbents of the under surface of the liver present, also, diversities, but they are seldom arranged into so many divisions as those of the upper surface. They communicate freely with the latter, and also with the profound, and, finally, assembling in the transverse fissure, they descend along the capsule of Glisson to join and anastomose with the contiguous trunks from the alimentary canal, from the pancreas, and from the spleen.

The Deep Absorbents of the liver follow the branching of the vena portarum, and, emerging at the transverse fissure, pass through the glands in the capsule of Glisson, associating themselves at the same time with the superficial trunks, and having a common termination with them. By putting a ligature around the vena portarum of a living animal, many of them are included in it; they then become exceedingly turgid, and are seen to diverge through the liver like the pori biliarii.

The liver is said to be more abundantly furnished with absorbents than any other viscus.

The Absorbents of the Spleen are also superficial and deep-seated. The former are between the peritoneal and the proper coat, and are injected with some difficulty in the human subject, but are very demonstrable and numerous in the calf. The latter emerge at the fissure of the spleen, and, traversing the glands that lie along the course of the splenic artery, receive successively the absorbents from the pancreas. They, finally, end in the thoracic duct, after reciprocal junctions, and anastomose with the vessels from the stomach and liver.

The Absorbents of the Pancreas are also numerous, and may be injected, contrary to their circulation, from those of the liver. They arise from the substance of the pancreas, like its vessels, by short trunks, which join those of the Splenic Plexus at right angles.

The Absorbents of the Kidneys are superficial and deep; the former, though numerous, are too small in the healthy state of these organs to be well seen, but they become very distinct from disease, and converge from its periphery to its fissure. The deep absorbents accompany the vessels, and, emerging with them at the fissure, are joined with the superficial; they all then run along the emulgent vessels, and have frequent anastomoses with those of the testicles or ovaries, and with those of the capsulæ renales. These absorbents may be filled by putting a pipe into the excretory duct of the kidney.

The Absorbents of the Capsulæ Renales unite to those from the kidneys, and, therefore, terminate with them in the lumbar glands.

Of the Absorbent Glands of the Abdomen.

The cavity of the abdomen contains many more glands than any other region of the body, on account of the very great extension of the serous system in it; of the functions exercised by its viscera; and

of its being traversed by the absorbents of the lower extremities. Many of these glands have already been described under the denomination of hypogastric, and external iliac; in addition to which, there are a few between the laminæ of the meso-rectum in front of the sacrum.

The Mesenteric Glands are exceedingly numerous, and amount to between one and two hundred; they begin at an inch or two from the small intestines, and may be traced to the root of the mesentery, being placed between its layers, on the convex side of the upper mesenteric artery. As the intestinal canal is longer in some individuals than in others, they are proportionately more numerous. Their largest size seldom exceeds that of an almond: those belonging to the jejunum are rather more developed than such as belong to the ileum, and they all augment in size as they approach the root of the mesentery.

The Glands of the Mesocolon are placed between the laminæ of this membrane, near the intestine; they receive the absorbents from the large intestines, are much smaller than those of the mesentery, and their number seldom exceeds fifty. Some few of them are situated near the root of the mesocolon. They are by no means so disposed to tumefaction from scrofulous affections as those of the Mesentery. It is stated by Winslow that he demonstrated, to the Academy of Sciences at Paris, chyle in the absorbents of the Mesocolon; this fact will assist us in accounting for the effects of nutritive clysters.

The Gastro-Epiploic Glands are situated between the laminæ of the omenta, where they join the curvatures of the stomach. Their number seldom exceeds four or five for each curvature, and they receive the absorbents of the stomach and omenta.

The Cœliac Glands are those which belong to the liver, the spleen, and the pancreas; they follow the course of the blood-vessels of these organs, and are traversed by their absorbents. The trunk of the vena portarum is surrounded by them, and Mr. Cruikshank says that he has seen the biliary and pancreatic ducts in a state of compression from their tumefaction.

The Lumbar Glands are very numerous and large; they are scattered over the whole region, from the base of the sacrum to the pillars of the diaphragm, lying on each side of the bodies of the lumbar vertebræ, and in front of the abdominal aorta and vena cava, being concealed by the root of the mesentery and of the mesocolon. They may be considered as continuations of all the preceding congeries of glands in the abdomen; and, therefore, when they, along with the vessels leading to them, are successfully injected, they form so thick a plexus of absorbents, reaching from the pelvis to the concavity of the diaphragm, that the great blood-vessels can scarcely be seen for them. Many of the vessels reaching from one to another are as large as a crow's quill.

SECT. VI.—ABSORBENTS OF THE VISCERA OF THE THORAX.

The Absorbents of the Lungs are thought to be next in abundance after those of the liver, and are likewise divided into two sets, the superficial and the deep-seated. The former are beneath the pleura pulmonalis. Mr. Cruikshank[1] says that they are not always to be found, though commonly he has readily shown them covering with their meshes the whole external surface of the lung. The larger meshes follow the interstices of the lobules, and within them are others of extreme delicacy. The same author states that one of the easiest methods of finding them is to inflate the lungs of a still-born child, from the trachea, and the air, in passing from its proper cells, will get into the absorbents; a puncture being then made into one of the latter, quicksilver may be very readily introduced. Some of their trunks penetrate to the bottom of the fissures of the lungs, and pass through the glands there, while others continue more superficial along the internal face of the lung, and so reach the bronchial glands.

The deep absorbents of the lungs observe the course of the pulmonary vessels and of the bronchia. They arise from the substance of the lung, anastomose very freely with the superficial vessels, and, in parting from the lung, pass through the bronchial glands, where they are joined by the superficial.

By the junction of the branches from the left lung, three considerable trunks are formed; one, which is sometimes the size of a goose-quill, is inserted into the thoracic duct, immediately behind the bifurcation of the trachea; another ascends between the trachea and the œsophagus, to join the thoracic duct near its termination; and the third joins the glands belonging to the absorbents of the heart.[2]

The absorbents of the right lung also coalesce into three principal trunks at the root of the lung: one of them ascends across the front of the superior cava, making, in its course, many elegant convolutions, and at length terminates in the second trunk on the left side.[3] The other trunks, ascending on the side of the trachea, and having traversed their glands, discharge into the right thoracic or brachio-cephalic trunk, or else near it into the right internal jugular, or into the right subclavian vein. There are, in these respects, diversities in different subjects.

The trunks of the Absorbents of the Heart follow the course of the coronary vessels, and distribute themselves by branches over its whole surface. They are, without previous management, easily discovered; but, if the heart be macerated in water for several days, so as to become somewhat putrid, the absorbents are filled and distended by the gaseous exhalation: on the puncture of one of these vessels, and the introduction of a pipe, they may all be readily filled.

There are three principal trunks of these absorbents; one follows the right coronary artery to the root of the aorta, and then ascends over the front surface of the latter to the top of its arch, where it

[1] Loc. cit. p. 194. [2] Cruikshank, loc. cit. [3] Ibid.

enters a gland. The other two trunks follow the two principal branches of the left coronary artery, and, coalescing near its origin, they ascend to the bifurcation of the pulmonary artery, and from that along the posterior face of the arch of the aorta, to enter a gland between it and the trachea. These several vessels subsequently traverse the lymphatic glands about the trachea, common to the heart and to the lungs, and ultimately terminate under varied circumstances, either directly or indirectly, in the left thoracic duct, the left internal jugular, or the left subclavian vein. Mr. Cruikshank says that the right coronary trunk empties into the lymphatic trunks of the right side of the neck, which shows that there is no fixed arrangement.

The Absorbents of the Pericardium may also be found; they terminate like the others of the heart, in the bronchial glands, and are particularly associated with those of the thymus gland.

The Absorbents of the Œsophagus are so numerous as to form a plexus from one end to the other of it. They run into the bronchial glands, and, therefore, have a common termination with the absorbents of the heart and lungs. Mr. Cruikshank says that he has reason to believe that he has seen life sustained through them alone and the absorbents of the mouth, in a case where stricture prevailed for some months just above the cardia, and where the food, after remaining for three or five minutes in the œsophagus, was vomited up.[1]

The Absorbents of the Thymus Gland are very abundant in the infant, but diminish with the rest of the structure in the adult: they terminate in the bronchial glands also.

SECT. VII.—ABSORBENTS OF THE PARIETES OF THE TRUNK.

In addition to the absorbents mentioned as belonging to the internal and external parietes of the pelvis, there are some others belonging to this cavity, as the ilio-lumbar, the sacral, and the circumflex.

The Ilio-Lumbar Lymphatics come from the parts to which the artery of the same name is distributed, and, assembling into two or more large trunks which pass beneath the psoas magnus muscle, one of them joins the lumbar glands, and another the hypogastric.

The Sacral Lymphatics arise from the cellular tissue in front of the sacrum and from the spinal canal in the latter. Emerging through its foramina in front, they terminate in the lower part of the lumbar and in the hypogastric plexus.

The Circumflex Iliac Lymphatics attending the artery of the same name arise from the lateral inferior parietes of the abdomen, in the thickness of its broad muscles; the several branches assemble into a

[1] A case somewhat similar occurred in the practice of Dr. Physick.

few trunks, which descend along the posterior margin of Poupart's ligament to terminate in the external iliac plexus.

The Epigastric Absorbents are derived from the inferior anterior parietes of the abdomen, along the region of distribution of the epigastric artery. Their trunks coalesce into larger ones, and descend along this artery to end in the external iliac plexus, near the crural arch.

The Lumbar Absorbents arise from the muscles of the loins, from the posterior part of those of the abdomen, and from the spinal cavity. Their trunks correspond with the lumbar arteries, and, passing beneath the psoas magnus muscle towards the spine, they terminate in the lumbar glands.

The Intercostal Absorbents take their origin from the parietes of the thorax, and following the course of the respective intercostal arteries, pass through some small glands occasionally found between the external intercostal muscles near the heads of the ribs. They are there joined by trunks from the spinal cavity and from the muscles of the back, and afterwards passing through some small glands on the front of the vertebral column, they anastomose more or less with one another, and finally terminate in the left thoracic duct. The absorbents of the pleura costalis and of the posterior part of the pericardium terminate in the intercostals.

The Internal Mammary Absorbents have their roots in the anterior region of the parietes of the abdomen, above the umbilicus, where they anastomose with the epigastric. They ascend, along with the internal mammary arteries, behind the sternal cartilages, pass through some small glands, and receive contributions from the anterior extremities of the intercostal spaces. Those of the left side, assembling into one or two trunks, cross in front of the left subclavian vein, traverse the inferior cervical glands, descend afterwards from this point, and terminate in the left thoracic duct, or in one of the contiguous trunks of the venous system. Those on the right execute the same movements, but terminate in the right thoracic duct, or in one of the contiguous venous trunks on that side.

The Absorbents of the Diaphragm are exceedingly numerous, and very much connected with those of the liver. The anterior ones join the internal mammary absorbents, while the posterior follow the phrenic arteries, or go to contiguous trunks belonging to the intercostals. The front ones on the right side, then terminate in the right thoracic duct, while the remainder go in the various routes of the absorbents, with which they are connected, into the left thoracic duct. They are principally seen on its upper surface. Mr. Cruikshank[1] says that he once saw them to the amount of three hundred or more, filled with chyle from the mesentery, that had passed through the substance

[1] Loc. cit. p. 90.

of the liver. Asellius was, therefore, probably justified, by an accident of this kind, in asserting that the lacteals went to the liver.

The Absorbents of the Female Mammæ, like their arteries and veins, are superficial and deep; the former attend the external thoracic blood-vessels, and the latter the internal mammary. The superficial arise from the circumference of the nipple, from the skin and cellular membrane, and, according to the injections of Mr. Cruikshank, communicate freely with the vesicles of the tubuli lactiferi. They run towards the axilla, having occasionally to pass through some glands which are situated half way; they then enter the first series of glands of the axilla in their direction, and afterwards others successively, until they terminate in the lymphatic trunks of the upper extremity, high up in the arm-pit. Some few of these superficial vessels ascend over the pectoralis major to the glands in the neck, just above the clavicle.

The deep absorbents of the mammæ arise from their thoracic face, and penetrating the intercostal spaces, join the absorbents that attend the internal mammary artery.

Of the Absorbent Glands in the Thorax.

There are, as mentioned, a few small glands in the intercostal spaces near the heads of the ribs between the internal and external intercostal muscles, intended to receive the lymphatics of these spaces. There are also several small ones situated on the front of the dorsal vertebræ, along the aorta and the œsophagus, in the posterior mediastinum. There are also from six to ten along the internal mammary artery; and some others in the anterior mediastinum, along the sternal face of the pericardium. They are said to be very rarely affected by disease.

The most considerable and striking glands in the thorax are those called Bronchial or Pulmonary, which receive the absorbents of the lungs. They cluster about the bifurcation of the trachea, and follow the bronchia for some distance into the substance of the lungs. They are from ten to twenty in number, and vary in size from an inch to a few lines in diameter. Till puberty they have a reddish color, but afterwards they become gray, and finally black, following in these respects the change of color in the lungs. According to Mr. Pearson, their complexion depends upon the deposit of pure carbon.

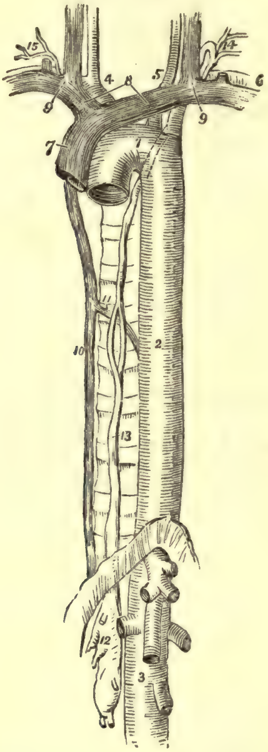
In pulmonary consumption these glands are always enlarged, and look scrofulous.

SECT. VIII.—OF THE THORACIC DUCTS.

The Left Thoracic Duct (*ductus thoracicus sinister*) is the main stream of the absorbent system to which almost all the others are but tributary, and by divers routes ultimately find their way into it. It begins about the second or third lumbar vertebra, in front of its body. Shortly after its commencement, while still in the abdomen, it suffers a dilatation more or less considerable, and varying in its shape in different subjects. This is called the Reservoir of Pecquet, or the Recep-

taculum Chyli; the dilatation, however, is frequently absent, and does not seem to be an essential part of the structure: in our preparations at the University, some have it, and others have it not.

Fig. 258.



A view of the course and termination of the Thoracic Duct.—1. Arch of the aorta. 2. Thoracic aorta. 3. Abdominal aorta. 4. Arteria innominata. 5. Left carotid. 6. Left subclavian. 7. Superior cava. 8. The two venæ innominatæ. 9. The internal jugular and subclavian vein at each side. 10. The vena azygos. 11. The termination of the vena hemi-azygos in the vena azygos. 12. The receptaculum chyli: several lymphatic trunks are seen opening into it. 13. The thoracic duct dividing, opposite the middle dorsal vertebra, into two branches, which soon re-unite; the course of the duct behind the arch of the aorta and left subclavian artery is shown by a dotted line. 14. The duct making its turn at the root of the neck, and receiving several lymphatic trunks, previous to terminating in the posterior angle of the junction of the internal jugular and subclavian veins. 15. The termination of the trunk of the lymphatics of the right upper extremity.

The thoracic duct enters the thorax between the crura of the diaphragm, to the right of and behind the aorta; it then ascends on the front of the dorsal vertebræ, between the aorta and the vena azygos, in front of the right intercostal arteries, and behind the œsophagus. At the fourth dorsal vertebra it begins to incline in its ascent to the left side, and then ascends into the neck near the head of the first rib; it rises commonly as high up as the upper margin of the seventh cervical vertebra; it then turns downwards and forwards, over the left subclavian artery within the scaleni muscles, and finally discharges into the angle of junction of the left subclavian and internal jugular vein.

The preceding is the most simple, and perhaps the most common form, under which the thoracic duct is presented, but varieties are continually occurring in its place and mode of origin, in its trunk, and its manner and place of termination. It commonly begins by the union of three absorbent trunks; one for each side of the pelvis, along with the corresponding lower extremity, and a middle one for the chyliferous vessels, which unites with the common trunk of the other two, a few lines above its point of formation. On other occasions, the chyliferous trunks join it in a confused manner by nine or ten distinct channels. Sometimes an intricate plexus of several large trunks, derived from the lumbar and mesenteric glands, by the gradual reduction of the number of meshes from the successive joining of trunks, begins to assume, at the crura of the diaphragm, the form of a solitary trunk, which is the thoracic duct. The trunk of the duct is also disposed to keep up the anastomosing plan, even in the thorax; we hence see it sometimes dividing itself into two or three channels of equal size, which unite again after a shorter or longer distance, and perhaps in a little space repeat the same arrangement: sometimes a small arm is sent off, which runs along for an inch or two, and joins into the parent stream; sometimes spiral turns are adopted by the thoracic duct; sometimes nodosities or small pouches are formed on its sides; sometimes it is dilated at intervals in its whole circumference. Sometimes it splits into several channels at its termination, one channel terminating in one vein and another in a contiguous one, of the several trunks forming the vena innominata; on other occasions, instead of entering into a venous trunk of the left side, it goes into the corresponding one of the right.

Commonly, it is about the size of a large crow's quill, but sometimes as large as a goosequill, or even still more voluminous, seeming to be in a varicose state, of which Mr. Cruikshank mentions an example where it was half an inch in diameter, and took two pounds of mercury to fill it. There is generally a pair of valves at the termination of the thoracic duct, or, if it be divided into several streams, there is a pair at the embouchure of each to keep the venous blood out of it. There are also valves in its length, but they are not numerous, and vary in different subjects.

The thoracic duct, as stated, is the grand outlet for the lymphatics of the left side of the head and neck, of the left superior extremity, of the left side of the thorax, of all the intercostal spaces, of the viscera of the abdomen and of the inferior extremities. Though those of the viscera of the abdomen and of the lower extremities have this route yet from the observations of Mr. Lippi, of Florence, as mentioned, they have also some more direct means of getting into the general circulation. For example, he has found several large lymphatic trunks emptying into the ascending cava, one of them opposite the third lumbar vertebra; another into the primitive iliac vein: he has also found some of the lymphatics of the liver discharging into the vena portarum.

The Right Thoracic Duct (*ductus thoracicus dexter*), as it is called, but more properly the Right Brachio-cephalic, after the name given by M. Chaussier to the vein, is not more than an inch long, and descends to empty itself, as mentioned, into the junction of the right internal

jugular with the right subclavian vein. It is derived from the lymphatic trunks of the right side of the head and neck, of the right upper extremity, the superficial lymphatics of the right side of the thorax, the lymphatics of the right lung, of the right side of the diaphragm, and some of those of the right side of the liver, the courses of all of which have been detailed.

Though the single trunk is formed from these several tributary streams, yet the latter have sometimes several embouchures into the venous system at or near the point mentioned, and, as on the other side of the body, there is a proper security, by valves, from the introduction of blood into them.

There is always an ample system of anastomosis, not only between the branches which concur to form the right and left thoracic ducts, but even between the ducts themselves,[1] so that, if one be occluded or impeded, its circulation can be turned into the other, as in the case of veins.

[1] Meckel, Man. D'Anat. tom. ii. p. 581.

BOOK IX.

PART I.

HISTOLOGY OF THE NERVOUS SYSTEM.

NERVOUS SYSTEM.

The Essential ingredient of this System is a peculiar animal matter called *Neurine*, the texture of which is so soft that, in the natural state, it has the least possible consistence. It is, therefore, protected in a variety of ways: by being enclosed in bone, where it is collected in large masses; and by being surrounded by ligamentous or cellular matter, where flexure is required.

The nervous system in man, and other vertebrated animals, consists in two portions of dissimilar forms: one is spheroidal, elongated at its base into a cylindrical process, and is contained in the cranium and in the spinal canal; the other is an assemblage of arborescent rays, which proceed from different points of the first portion to every part of the body. The first portion is the Central or Internal part of the nervous system, composed of the Brain and Spinal Marrow; while the radiating portion is called the External or Peripheral, and consists in the Nerves of the brain and spinal marrow.

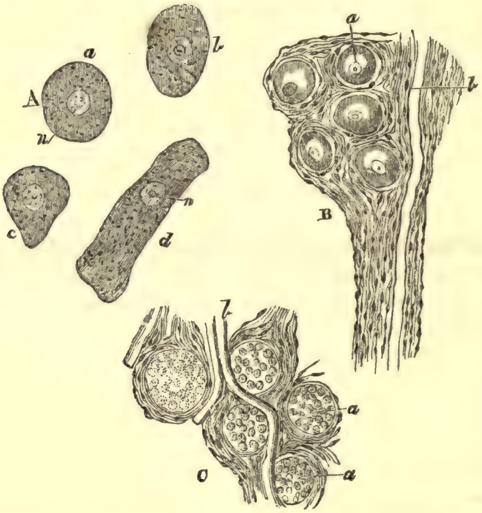
The nervous system is remarkable for its symmetry. As it is universally double, it very seldom happens that any striking difference of it on the two sides of the body is manifested, particularly as regards its Central portion; it is said, however, that aberrations, in this respect, are more common in man than in other mammiferous animals.

The central portion of the nervous system is composed of two kinds of the substance called Neurine, distinguished by their color and relative situation: One is improperly enough called Medullary (*substantia medullaris*), but, as the name is now sanctioned by universal usage, it is impossible to dispense with it. The other is called Cineritious (*substantia cinerea*), with, perhaps, sufficient propriety, from its color. They are both of a soft pulpy consistence, and constitute the chief mass of the brain and spinal marrow: some anatomists have desired to add, from a slight distinction of color, two other substances, a yellow and a black, but that seems unnecessary, and has not been generally

acknowledged. The substances differ from one another in regard to their quantity, the medullary being more abundant than the cineritious; it is also harder, and receives fewer vessels.

Nerve-Vesicles or *Cells*, also called ganglionic globules. The cineritious or gray substance of the brain and spinal cord is formed of globules (according to Valentin) of a spheroidal shape. These globules or vesicles have a nucleus, and in the circumference of this a nucleolus. The quantity of these globules determines the shade of the gray substance; but there are parts of the latter of a darker color, which is owing to pigment globules in the nerve cells.

Fig. 259.



A. Ganglionic nerve-cells detached. B and C. Small portions of a ganglion in which the nerve-cells are seen imbedded among the gelatinous fibres. In C they are still covered by their capsule of nucleus-like corpuscles (*a*, *a*). Tubular fibres (*b*, *b*) are seen passing through the ganglion. *n* indicates the nucleus of the nerve-cells.

The shape of the nerve-vesicle is not uniform; originally it was globular, but it departs from that sometimes from the influence of pressure, but more commonly from an irregular growth which sends out caudate or stellate roots in different directions. These roots are made of a fine granular material, identical with that in the interior of the cell. Traced to a distance, they are found to divide and subdivide into extremely fine filaments, some of which interlace with the corresponding elongations of other nerve-vesicles, while others unite with the axis cylinders of the nerve-tubes. The pigment globules cluster around the nuclei of the cells, and seem to approximate to the Hæmatin of the Blood. The vesicles and processes are covered in many cases with a layer of soft granular substance, which adheres closely to them; an example of which is in the outer part of the cortical substance of the brain. In other instances, the envelop of the cell itself is covered by another envelop composed of smaller cells, as exemplified

in the inner portion of the cortical substance of the brain and also in the smaller ganglia. The diameter of the globular vesicles is from $\frac{1}{1250}$th to $\frac{1}{300}$th of an inch; the others are uncertain, owing to their caudate or root-like projections, which may be compared to the roots of the white potatoe.

In the brain and in the spinal marrow, the nerve-vesicles cluster together, and are deposited in a fine granular matter, the groups being penetrated and invested by a fine intertexture of capillary blood-vessels.

It is thought by Müller that the cineritious globules of the nervous system are connected together by peculiar filaments; the same arrangement existing in the ganglia of nerves.

The *Tubular Fibres* or the Medullary Matter, when quite fresh and scraped in particular directions, has a linear or filamentous condition, which may be rendered still more distinct by hardening it in alcohol, in boiling oil, in a solution of the neutral salts, or in diluted mineral acids. If an attempt be then made to tear it, it will be immediately perceived that the fibres separate in a fixed direction, and in no other. These fibres are, in some instances, parallel; in others, concentric; and in others, diverging or converging.

The elementary form of white nervous matter consists in those filaments or threads, and which in the nerves are held together by areolar substance. Each filament in both the brain and the nerves consists in a membranous tube, containing a soft matter. In the brain the latter is a mere pulp, but in the nerves it may be separated from its tube in a linear form for some distance. The elementary nervous fibres are smaller in the brain and spinal marrow than elsewhere; in the nerves themselves they vary from $\frac{1}{2000}$th to $\frac{1}{4000}$th of an English inch.

All nerve fibres are cylindrical, though this shape is easily disturbed by the manner of examining them. When tested carefully, no doubt is left on this head, and especially if the fibre be taken, as suggested by Müller, from the Valve of the Brain.

The fibres or filaments of the brain, when pressed upon, become swollen at intervals so as to be knotted or like a string of beads, and if the pressure be much, they are separated into globules of different sizes.

This knotted appearance upon compression of the cerebral substance and spinal marrow first observed by Ehrenberg, is also ascertained by him to belong to the nerves of special sensation, as the Olfactory, Optic, and Auditory. The sympathetic has also, to a limited degree, this feature. It was at first supposed to be from some peculiar attribute, but now is accounted for by the greater delicacy, at points, of the investing membrane of the filaments. The varicose or knotted condition may be evolved possibly by a species of contractility being brought into play by the method of examination, of which we have an example on a large scale in the Medulla Spinalis, which when taken from the spinal canal becomes corrugated by a spontaneous contraction.

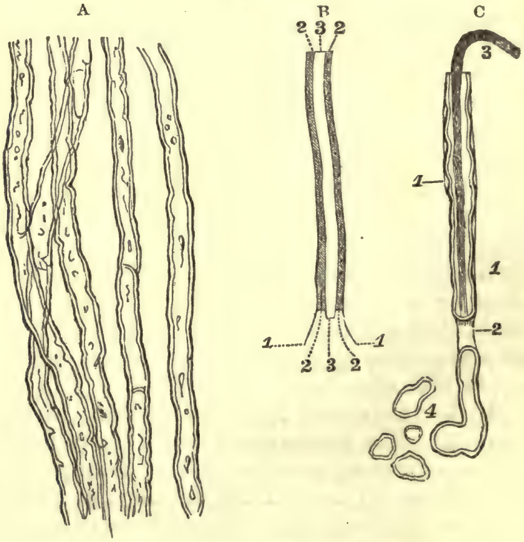
The two substances are variously placed in different parts of the nervous system: the surface of the cerebrum and of the cerebellum is formed by the cineritious matter, and the interior principally by medullary; while the surface of the pons, of the crura, and of the spinal

marrow, is medullary, and their interior cineritious. Again, in other points, they are intermixed both in the encephalon and in the ganglia. The medullary matter is always so arranged that it is never interrupted, but forms a continuous whole. While the cineritious is in detached masses, and is found where the central extremities of the nerves are implanted, or where there is an increase of medullary fibres, some anatomists have even declared that it existed at the peripheral extremity of the nerves, particularly in the rete mucosum of the skin and in some of the organs of special sense.

The fibrillæ of the medullary tissue are united by a very fine and thin cellular substance, which may be seen by tearing them apart. This cellular substance is more condensed near the surface of the brain, where it is formed into a highly vascular membrane (the pia mater), and is continued along the nerves as a neurileme, or covering to them.

When but few of the tubular or medullary fibres are under the microscope they are transparent, and if quite fresh resemble a thread of glass, with a gently waving outline. Their diameter varies from the $\frac{1}{7000}$th to the $\frac{1}{8000}$th of an inch; not only in different fibres, but in the progress of the same one. Under favorable circumstances the fibre is seen to be composed of its membranous tube, and the nerve substance itself under two different forms of matter; the exterior being a hollow cylinder called the white substance by Schwann, within which is another

Fig. 260.



A. Tubular nerve-fibres, showing the sinuous outline and double contours.—B. Diagram to show the parts of a tubular fibre, viz.: 1, 1. Membranous tube. 2, 2. White substance or medullary sheath. 3. Axis or primitive band.—C. Figure (imaginary) intended to represent the appearances occasionally seen in the tubular fibres. 1, 1. Membrane of the tube seen at parts where the white substance has separated from it. 2. A part where the white substance is interrupted. 3. Axis projecting beyond the broken end of the tube. 4. Part of the contents of the tube escaped.—(Sharpey and Quain.)

substance filling it, and called the axis cylinder by Purkinjé. Both substances are affected by exposure, the first by refracting light more

strongly and changing color, and finally both assume a confused granular condition. The tubular fibres, though collected into bundles, keep distinct from their beginning to their termination, like threads in a skein.

The *Gelatinous Nerve Fibres*, also called the gray and the organic, are found principally in the sympathetic nerve, but they also exist in the cerebro-spinal nerves. In both situations they are associated with the white fibres. They are tenacious, difficult to part, and are asserted by some as being occasionally split into smaller filaments at their ends. They are also flattened, translucent, faintly granular, and have numerous corpuscles resembling cell nuclei lying on them. These nuclei are round, oval, or fusiform, with their long diameters placed longitudinally to the nerve. They are furnished with one or more nucleoli, and the doubts as to their real character are now removed, by their continuity with the elongated processes from the nerve-vesicle or ganglionic cell, and with the tubular fibres.

Vauquelin's chemical analysis of the brain afforded the following results:—

Albumen			7.00
Adipose matter	Stearin	4.53	5.23
	Elain	.70	
Phosphorus			1.50
Osmazome			1.12
Acids, Salts, and Sulphur			5.15
Water			80.
			100.00

The Central Nervous System is abundantly supplied with blood-vessels, but lymphatic trunks have not yet been injected in it.

The Peripheral Portion of the Nervous System, or the Nerves, are formed by parallel anastomosing fasciculi of fibres, perceptible to simple inspection, which may be reduced into fibrillæ, and then again into filaments as small as the thread of a silk-worm. The finest filament is enclosed in its appropriate sheath, so that the latter is a tube filled with nervous matter as in the tubular fibres of the brain. The nervous matter is soluble in an alkali, and in that way may be removed; the canals may then be filled with quicksilver or air, and their existence demonstrated. On the other hand, nitric or muriatic acid dissolves the sheath, but hardens the nervous matter, and renders it more distinct, so that the finest filaments are made obvious.[1] In either case it is evident that the shape of the nerve is preserved. These filaments are supposed to be precisely the same with the fibres of the brain, excepting that their sheaths keep them more distinct from one another.

The Primitive fibres of the nerves have close correspondence in all animals.

[1] Reil, de Struct. Nerv.

The cerebro-spinal nerves contain a small intermixture of gray fibres, derived, probably, from ganglionic globules. The sympathetic has in return, though principally formed of grayish fibres, some few white fibres. In the common nerves this modification by the presence of gray fibres is seen principally at the points of junction with the sympathetic.

Neurilemma.—The sheath of the nerves, or the Neurileme, is formed by an extension of the pia mater and of the dura mater along the nerves. It makes a general envelop to the nervous fasciculi, as well as a particular one to each fibre, and is continuous, at its central extremity, with the pia mater. Its divisions branch off and unite again at intervals, forming a species of reciprocal anastomosis, sufficiently represented by the plan of the large nervous plexuses, as they occur in various parts of the body. It is the general envelop which is obviously continuous with the pia mater, but the particular sheaths of the finer fibres are lost insensibly, so that these fibres appear naked in the centre of the nerve, at its central extremity, unless examined with a good glass. The same destitution of neurilemmatic covering is observable at the peripheral extremities of the nerves, wherever the latter can be traced. From the increase in size, the additional solidity, and the close adhesion of the nerves to the dura mater, where they pass out of their several foramina in the spine and cranium, there is no doubt that the dura mater contributes to the neurileme, though its structure is altered and made much less dense. The best evidence of this is the sheath of the optic nerve, and of the spinal nerves. This opinion, advanced by the ancients, has been strongly contested by Haller,[1] and by Zinn.[2] The tunica arachnoidea is too fine to admit of any positive opinion about the extent to which it follows the nerves.

The neurileme has but little contractility, is solid and difficult to tear, and is supposed to be the secretory organ of the medullary substance.

The nervous fasciculi are, moreover, held together by cellular substance, which has, in the progress of life, a tendency to the depositing of fat. This cellular substance, in neuralgic affections, is subject to infiltrations and redness, whereby it becomes hard. This circumstance has induced pathologists to consider the pain as depending upon its inflammation.[3]

The optic nerve, owing to the size of its canals, furnishes the best example of structure, and the nerves of the muscles are next. There are, however, some peculiarities in different nerves; as the observations of Sir Everard Home have ascertained that the medullary filaments of the optic nerve augment in numbers and diminish in volume, from its origin towards its termination. The original observation on the tubular structure of the nerves and brain is due to Reil[4] and Fontana; since

[1] Prim. Lin. [2] Mémoires de Berlin, 1753.

[3] Béclard, Anat. Gén. p. 665.

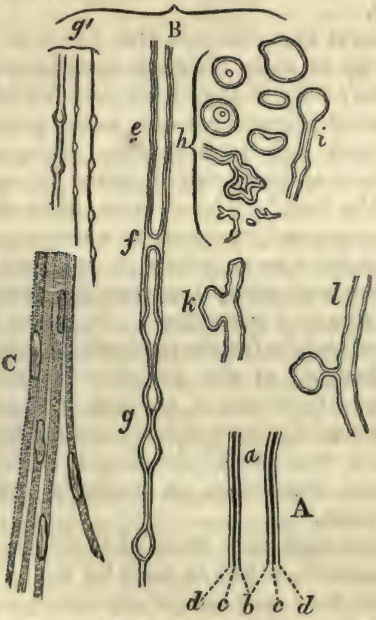
[4] Reil, de Structura Nervorum. Halæ Saxonum, 1796. Henle, Remak, Valentin and several others, all of more modern date, have confirmed more or less the views of Reil and Fontana, and added to them.

then it has been confirmed by numerous others, so that it may now be considered as one of the well-ascertained points of anatomy.

In addition to the preceding structure, the nerves present a satin-like undulated surface, with small bands that pass somewhat spirally and in a zigzag direction. The latter appearance is illusory, and depends upon the contraction or shortening of the nerve when not stretched; its seat is in the neurileme, and it accordingly disappears upon extension.

Some years ago MM. Prevost and Dumas asserted that they had found the ultimate filaments of nerves[1] as distributed to muscles, terminating in loops, either by anastomosis with other filaments or in a loop of the individual filament. The observations of Valentin and Emmert corroborate those of the preceding gentlemen. Valentin has found

Fig. 261.



A. Diagram of Tubular Fibre of a Spinal Nerve.—*a*. Axis cylinder. *b*. Inner border of white substance. *c*, *c*. Outer border of white substance. *d*, *d*. Tubular membrane. B. Tubular fibres; *e*, in a natural state, showing the parts as in A. *f*. The white substance and axis cylinder interrupted by pressure, while the tubular membrane remains. *g*. The same, with enlargements. *h*. Various appearances of the white substance and axis cylinder forced out of the tubular membrane by pressure. *i*. Broken end of a tubular fibre, with the white substance closed over it. *k*. Lateral bulging of white substance and axis cylinder from pressure. *l*. The same more complete. *g'*. Varicose fibres of various sizes, from the cerebellum. C. Gelatinous fibres from the solar plexus, treated with acetic acid to exhibit their cell nuclei. B and C magnified 320 diameters.—(Todd and Bowman.)

the same arrangement in the iris and in the ciliary ligament; in the cochlea of birds; in the sacs of the teeth; and in the skin of the frog. This arrangement does not, however, exist as a universal one in the nerves of sensation, as in the retina of the vertebrated animals and

[1] See Histology of Muscles.

of insects:[1] in many of the nervous filaments of the labyrinth, which, like those of the retina, have a free extremity; and also in the pituitary membrane according to Treviranus. In the mesentery of the frog the nerves terminate in a net-work according to Schwann.

The nerves abound in blood-vessels; when a vascular trunk reaches them, one of its branches ascends and another descends, and, if successfully injected, the neurileme is covered by its capillary ramifications. As in the brain, the lymphatics have not yet been injected.

There are three modes by which the nervous fasciculi unite with one another; anastomosis, plexus, and ganglion. Anastomosis is the junction of the filaments, either of the same nerve or of different nerves, and the examples of it are very abundant. Plexus is an anastomosis on a larger scale, and occurs between the larger fasciculi of the same nerve, or of different nerves, whereby a very complete intertexture of their fibres occurs.

Kronenburg asserts that the primitive fibres of the cerebral nerves continue separate up to their ultimate distribution, and that, in their apparent union, they only change from one fasciculus to another, and that this arrangement prevails not only in the plexus, but in every part of the nervous trunk and its branches. This conclusion he founds upon his observations of the brachial plexus in mammalia, and of the lumbar plexus in the frog.[2] This opinion, first advanced by Fontana, has now been so repeatedly proved by observation up to the present time, that it is laid down as an axiom in anatomy that from whatever point a nervous fibre may arise, it runs to its termination as a thread without coalition with any other fibre. It hence happens that the innumerable points of origin for the nerves have equally numerous points or places of termination, on the peripheral parts of the body. The accuracy of our sensations and of nervous intercommunication is supposed to depend essentially upon this distinction being observed; otherwise the impressions would be of the most confused kind, and, as Müller observes, no local impression on a single definite point would be perceived by the brain.[3]

The above rule, though now established for the white fibres of the brain and spinal marrow, is not so fixed for the gray fibres, as there is some doubt whether they may not be connected in the ganglia.

Ganglions are knots which occur in the course of nerves, whereby they have, for the time, a great augmentation of volume. The ganglions have a great variety of form and size; they are parabolic, circular, crescentic and so on, and, in their general appearance, hardness, and color, resemble somewhat lymphatic glands. When submitted to maceration, they are resolved into two kinds of substance, the tubular fibres and the ganglionic globules: the first is filamentous and continuous with the nerves, adhering to the ganglion; and the other is gelatinous in its consistence and of a reddish ash color. The filaments, in

[1] Müller's Report on Nervous System.
[2] Ibid., p. 232, for the year 1836.
[3] Page 651.

penetrating the ganglions, are deprived of their strong neurileme, which is continued into a sort of capsule that surrounds the ganglions. They pass uninterruptedly through the ganglion, and, therefore, continue the several nervous cords into one another, but in a complicated way. The elementary arrangement of the nervous ganglia consists in grayish matter of the same description with that in the brain, and of nervous filaments in continuation with the nerves connected with the ganglion.

Fig. 262.

Globules of the Gray Matter of Ganglia, after Valentin.—In one, a second nucleus is visible. The nucleus of several contains one or two nucleoli.

The nerves are resolved into a very fine intertexture or plexus, which forms its meshes around the globules of gray matter, and are then recomposed to pass out on the other side of the ganglion. The absolute connection of tubular fibres with the ganglionic cell, after long doubt, appears to be now settled by Wagner, who has observed in the ganglia of the spinal nerves, trigeminus, and sympathetic of certain fishes, a nerve-fibre entering at one end of a cell, and departing at the other. The cell-wall appears to be continuous with the sheath of the nerve, fibre. He concludes from this that there is no multiplication of fibres in their passage through a ganglion. The ganglions, like other parts of the nervous system, are very vascular.

The Ganglions are said to be simple and compound; the first is where a single nerve produces the ganglion, and the second where the filaments of two or more nerves concur to form it. The simple ganglions are invariable in their form and situations, and belong to the spinal marrow, being formed upon the posterior fasciculi alone: this fact was first pointed out by Haase,[1] and has been subsequently confirmed by the observations of Scarpa and of Prochaska, and by the admission of anatomists generally. Their exterior envelop is continuous with the dura mater, and the internal with the pia mater, from whence they have more firmness than other ganglions. The compound ganglions are found at divers stations about the body.

The attention of the profession was much directed to the microscopical observations of Professor Ehrenberg, of Berlin, on the structure of the Nervous System.[2] The following is a summary of his doctrines on this subject—the instrument used being a microscope of Chevallier, of Paris,

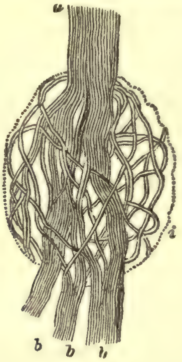
[1] De Gangliis Nervorum, Lipsia, 1772.

[2] Memoir of 1833–36 to the Academy of Sciences of Berlin, translated by David Craigie, M.D., Edin. Med. and Surg. Journ. Oct. 1837; copied into Essays on Physiology, Phila. 1838.

augmented in power by Pistor and Schiek, of Berlin. It will be seen that, in some respects, his views are peculiar, especially in regard to the knotted nerve-fibre, and in regard to ganglions.

The organic structure of the Encephalon, the Spinal Cord, and the Nerves, presents:—

Fig. 263.



Second Abdominal Ganglion of the Greenfinch, slightly compressed. The course of the nerve-tubes only is represented.—*a*. Entering fibres. *b*. Emerging fibres. *i*. Outline of investing tunic, beneath which vesicles exist. (After Valentin.)

1. A set of straight tubes, like a string of mock pearl beads, and whose spheroidal enlargements are kept apart by an intermediate canal. These nodulated tubes he calls varicose, from their mechanical conformation, or resemblance to varicose veins; he also calls them jointed or articulated from their shape. These are parallel to one another, cross occasionally, are never seen to anastomose, and are like filaments: they contain a peculiar matter, designated the Nervous Fluid (Liquor Nervosus of Haller), and are confined chiefly to the white or medullary portion of the Encephalon and Spinal Marrow. They are of a milky color.

2. A set of filamentous bodies, which are hollow or tubular, of a simple cylindrical shape, that is, not having the irregular surface or nodes of the preceding. They are uniform, and generally larger than the nodulated, though the latter are in places continued into the former. They contain a white viscid fluid, to which he gives the name of Medullary, and which is less transparent than the Nervous. These tubes are the one hundred and twenty-ninth of a line thick in the middle; they are elementary, are not surrounded individually by a neurileme, are collected into fasciculi, which, in that state, have a neurileme, and these fasciculi are grouped into larger cords or nerves proper. The elementary tubes, though they pass from one fasciculus to another, do not discharge or empty into one another, their anastomosis being nearly one of adhesion. These cylindrical tubes exist chiefly in the nerves.

3. A granulated matter, some of the grains of which are very fine and some coarser, being disseminated through the others.

This is confined to the cineritious substance of the convolutions of the cerebrum, to the laminated surface of the cerebellum, and to the cineritious part of the Spinal Marrow.

4. The articulated tubes present patulous ends to this granulated collection, which ends are fitted for the purpose of receiving them directly, and for the distillation of the Nervous Fluid (Liquor Nervosus).

5. The cylindrical tubes of the motiferous nerves are immediate continuations of the nodulated tubes. This is perceptible in the nerves of the medulla spinalis and of the cerebrum, excepting the Olfactory, the Optic, and the Auditory Nerves, which are unchanged nodulated tubes.

6. Professor Ehrenberg's observations on living nerves have not yet exhibited the circulation of a nervous fluid in them, but he declares neither for nor against it.

7. The Ganglions, or Nervous knots, consist of the articulated tubes alone, or mixed with the cylindrical tubes. They have also a very fine net-work of blood-vessels, with nervous granules intermixed with them. They are, in fact, comparable to brains.

The Nervous System is the seat of intelligence, and also extends its physical influence to every part of the body. Both the one and the other qualities reside in its central portion: the first in the brain, and the second in the spinal marrow. When the communication between the brain and the spinal marrow is interrupted by an accident, or in an experiment, the difference between the influence of the two is strongly marked:[1] the influence of the brain seeming to be entirely intellectual, so that an animal will even bear its removal without immediate death; while the influence of the spinal marrow is so indispensable to life, that its destruction is followed by instantaneous and perfect death.[2] Under common healthful circumstances, however, the two seem to exercise a mixed influence on all parts of the body; as, for example, upon the reception of distressing intelligence, the stomach ejects its contents, or refuses to receive more; alarming intelligence causes the heart to flutter and to palpitate, and both the bladder and the intestines to evacuate their contents. On the contrary, a proper degree of corporeal exertion strengthens the intellectual operations, while its excess debilitates them. That these several nervous influences are seated in the central part of the nervous system seems proved by the fact that, where there has been a congenital deficiency of all the limbs, or an accidental one, which, of course, removes a very considerable portion of the peripheral part of the nervous system, animal life and the intellectual operations have still gone on vigorously.

The following are some of the physical functions over which the nervous system seems to preside:—

Digestion; the whole alimentary canal, from the mouth to the anus, is under its influence: first of all in mastication, then in swallowing, afterwards in digestion and the absorption of chyle, and finally, the passing of the effete matter out of the body. It has been sufficiently proved, by the experiments of several physiologists, that the section of the par vagum destroys the faculty of digestion.

Respiration; the mechanical act of this process, that by which the

[1] Legallois on the Principle of Life.

[2] "Observ. and Exper. on the Nervous System, by W. E. Horner, M. D," being in confirmation of Legallois' experiments. See Chapman's Med. and Phys. Journal, vol. i. p. 285.

cavity of the thorax is enlarged so as to admit of the introduction of air, evidently depends upon the phrenic and the intercostal nerves. If the nerves which supply the structure of the lungs be alone intercepted, as the par vagum, either by ligature or section, the changes on the blood produced by respiration cease, and the animal dies.

Secretion, exhalation, absorption, and animal heat seem also to be dependent upon the integrity and the activity of nervous influence. The action of the heart, sensation and voluntary motion, are in the same predicament.

The manner in which these several kinds of innervation are produced is unintelligible. One has supposed it to consist in a vibration of the elementary fibres of the nerves; another in an agitation of their elastic globules; another in the transmission of an imponderable fluid, as ether, magnetism, electricity, and Galvanism. Reil has proposed, on this subject, what has been termed a chemico-vital hypothesis: according to him, the general action of parts depends upon their form and composition; consequently, when the two latter vary, the first does also. M. Béclard[1] inclines to the opinion that "the nervous system is the elaborator and conductor of an imponderable agent, like electricity or magnetism; and that by it we can explain all the phenomena of innervation. The relation between the benumbing influence of electric fish and Galvanic phenomena on one part, and ordinary nervous action on the other; — the practicability of causing Galvanic phenomena by the nerves and muscles alone;—the possibility of producing muscular contraction, the chymifiant action of the stomach, the respiratory action of the lung, &c., in substituting a Galvanic for a nervous influence;—the existence of a nervous atmosphere, acting at a distance around the nerves and muscles, and between the ends of divided nerves;—the wrinkling of muscular fibres in contraction, and the relation of the finest transverse nervous fibre with those wrinkles: are phenomena of innervation which nearly approach certain electro-magnetical ones."

This subtile fluid, according to M. Béclard, seems to be formed everywhere, but principally in places where there is much vascularity along with the ash-colored substance. It impregnates all the humors and organs. The blood seems to be especially endowed with it, and owes to it the properties which distinguish it during life. In consequence of which, life is essentially connected with the reciprocal action of the blood upon the nervous substance, and of the nervous substance upon the blood.[2]

The late Sir Charles Bell, of Edinburgh, presented, in a very interesting light, certain functions of the nervous system:[3] by his researches it appeared that, besides the nerves of vision, smell, and hearing, there are four other systems, having different functions, and extended through the whole frame: those of Sensation; of Voluntary Motion; of Re-

[1] Anat. Gén.

[2] M. Rolando (Saggio sulla vera struttura del cervello, e sopra le funzioni del sistema nervoso, 1809, Béclard, p. 622) has been so much taken with the Galvanic manifestations of the nervous system, that, in the laminated arrangement of the cerebellum, he has only seen a modification of the Voltaic pile.

[3] Exposition of the Natural System of the Nerves of the Human Body, Philad. 1825.

spiratory Motion; and Nerves, which give unity to the body in harmonizing the functions of nutrition, growth, and decay, or whatever else is indispensable to animal existence.[1]

According to this theory, the several filaments of a nerve exercise one or the other function, but only the one; these dissimilar filaments, being bound up in the same fasciculus, constitute a nerve or fascis, and they never exchange power with one another; their anatomical differences, however, are such as not to make obvious one kind of filaments from the others. Several columns of nervous matter form the spinal marrow, six in all, three on each side; the anterior for voluntary motion, the posterior for sensation, and the middle for respiration; and it is probable that still more may be found out. The first and the third ascend into the brain, and the middle stops short in the medulla oblongata; hence, the function of respiration goes on so long as the medulla oblongata remains entire. These few principles, supported by several experiments, enabled Mr. Bell to bring forward a system of no small importance, on the anatomy and physiology of the nervous system.[2]

The development of the nervous system is amongst the earliest processes in the distinct evolution of the fœtal organs.[3] At the end of the first month, when the head is a mere swelling of one end of the small maggot-like being, the brain and the spinal marrow are not by any means distinct, but the parts being transparent, a limpid fluid holds their place. About the fifth or sixth week, the embryo having acquired a length of five or six lines, the rudiments of the brain appear as vesicles containing a whitish and almost diaphanous fluid, while the spinal marrow represents a long canal containing the same, and communicating with the cerebral vesicles.

In the early part of the third month, the brain and spinal marrow show very distinctly the rudiments of the several cavities, elevations, and fasciculi, which mark their subsequent mechanical arrangement of surface; and from this period it is no longer difficult to trace the successive development of each part to the degree of perfection which it has at the time of birth.

From the many observations made by Tiedemann on these points, he has deduced the conclusion that the brain is produced by the superior part of the spinal marrow; that is to say, by the medulla oblongata, which grows and is developed for the purpose. That this is proved, in the extension upwards and forwards of the two principal fasciculi of the spinal marrow; and by a canal which is found in the spinal marrow of the fœtus, being extended to the fourth, and even to the third ventricle; also by the cerebellum proceeding evidently from the medulla spinalis

[1] For a further view of the present physiology of the Nervous System, see Human Physiology by Robley Dunglison, M. D. Professor, &c.; Muller's Physiol.; and Carpenter's Princ. of Human Physiol. Phila. edit. 1850.

[2] The same subject was taken up, in an inaugural thesis, by a zealous and intelligent graduate of the University, now dead; and, by a series of ingenious experiments, seems to have been generally proved and illustrated. Remarks on some of the Nervous Functions, by J. P. Hopkinson, M. D., in Chapman's Med. and Phys. Journal, 1823, vol. vi. p. 240.

[3] Anat. du Cerveau, par F. Tiedemann, traduit par Jourdan, Paris, 1823; Anat. Comp. du Cerveau, par E. R. A. Serres, Paris, 1824. The subject has also been treated more lately by several others, as Bischoff, Burdach, Baer, Valentin.

since its two crura may be traced growing from it, and subsequently uniting over the fourth ventricle, so as to form the especial structure of the cerebellum; also, by the tubercula quadrigemina being derived from the corpora olivaria of the medulla oblongata, and by the thalami and the corpora striata proceeding from the corpora pyramidalia, and finally, forming the hemispheres of the cerebrum.

In addition to the preceding proofs, comparative anatomy furnishes other illustrations. The brain becomes more and more complex as one ascends from fish to reptiles, from the latter to birds, and then to mammiferous animals. The spinal marrow is very voluminous in the inferior animals, while the brain only forms an appendix to it; whereas if the spinal marrow were an appendix to the brain, we ought to find the last of a prior formation in fœtuses; and also in a perfect state in the lower animals, before a medulla spinalis could be observed.[1]

[1] Tiedemann, loc. cit. p. 157.

BOOK IX.

PART II.

ON THE SPECIAL ANATOMY OF THE CENTRAL PORTION OF THE NERVOUS SYSTEM.

CHAPTER I.

OF THE SPINAL MARROW AND ITS MEMBRANES.

THE Spinal Marrow (*medulla spinalis*), though frequently described after the brain from the comparative size of the two, as a continuation or appendage of it, has precedence, as seen, in their formation in the embryo, and in their importance to the functions of the animal system. It will, consequently, be proper to give it that priority in description to which its natural rank entitles it.

It is placed within the vertebral cavity, and extends from the first vertebra of the neck to the first or second vertebra of the loins, inclusively. It is surrounded by three membranes, of which the Dura Mater is external, the Pia Mater internal, and the Tunica Arachnoidea between the other two.

SECT. I.—MEMBRANES OF THE SPINAL MARROW.

Of the Dura Mater of the Medulla Spinalis.

This membrane, forming the exterior envelop of the spinal marrow, extends from one end of the spinal canal to the other, being continuous above with the dura mater of the brain, and terminating below in a cul-de-sac, or closed extremity, which sends off branches corresponding with the several nerves there. It does not adhere to the surface of the spinal canal, but lies loosely attached to it, with the exception of the first cervical vertebra, to which it is closely fastened. Between it, and the ligaments and periosteum on this surface of the bones of the spine, is a long, loose, and spare cellular substance, generally somewhat watery, and containing in the lumbar and sacral regions, a reddish, adipose matter.

This membrane is so much larger than the medulla spinalis that it invests it very loosely and always presents a collapsed appearance. Where the nerves penetrate, it furnishes to each one a sheath as far as the intervertebral foramen. Having reached the intervertebral foramen, the sheath then enlarges so as to enclose the ganglion there, adheres by cellular substance to the contiguous periosteum, and is then insensibly lost in the tunics of the nervous trunk. These sheaths are longer for the cauda equina than elsewhere, and, of course, observe the same successive obliquity with the nerves to which they belong.

The internal surface of the dura mater is smooth and shining, which is owing to the tunica arachnoidea being reflected over it.

This membrane has a fibrous texture, and, with inconsiderable exceptions, is like that of the brain both in appearance and organization.

Of the Tunica Arachnoidea of the Medulla Spinalis.

This serous membrane is next to the dura mater, and is easily distinguished by its extreme delicacy, thinness, and almost perfect transparency. It is destitute of red blood-vessels. It forms a complete envelop for the medulla spinalis, and adheres to the Pia Mater very loosely by means of long, slender, and scattered filaments of cellular substance. If the dura mater be slit up its whole length before and behind, and a blowpipe be introduced at one end of the medulla spinalis, between the pia mater and the arachnoidea, inflation will cause the latter to rise, and to present itself as a long capacious tube, detaching on each side processes which surround the roots of the nerves. These processes having reached the points where the nerves penetrate the dura mater, are then reflected upon its internal face, being spread over it, and thus give it the glistening appearance. The processes enclosing the fasciculi of the spinal nerves are particularly conspicuous about the Cauda Equina.

Of the Pia Mater of the Medulla Spinalis.

This third envelop of the spinal marrow forms also a complete investment of the latter, and adheres very closely to it. Its external face is smooth, and is in contact with the arachnoidea, from which it may be readily separated by inflating the latter. But from the middle of its internal face both anteriorly and posteriorly, a process or partition penetrates into the middle fissures of the medulla spinalis, and reaches to their bottom. From these partitions there proceeds a great number of small vascular canals, which pass in various directions through the medulla, and anastomose freely with each other. This arrangement is rendered sufficiently obvious by injecting the blood-vessels, and then destroying the medulla in an alkaline solution: or if the medulla be hardened by neutral salts or acids, it splits into many longitudinal radiated laminæ, divisible into cords, whereby the arrangement is made equally manifest.

At the inferior end of the medulla the pia mater becomes a single spindle-shaped cord, the *Central Ligament* (*filum terminale*), which is continued among the cluster of nerves constituting the Cauda Equina, to the lower

end of the tube formed by the dura mater, and there it joins with the latter. As a membrane, the pia mater is much more complete than the corresponding one of the brain, has more strength, but is not so vascular. Its thickness increases in its descent. It is of a yellowish-white color, and has white and yellow ligamentous matter in its composition. It seems to hold the medulla somewhat in a state of compression, for, when a puncture is made through it, the medullary substance protrudes like a hernia. It goes from the medulla to the fasciculi of nerves, and contributes to their neurileme or sheath.

The pia mater seems to impart great elasticity to the spinal marrow, for, when the latter is detached from the spine by the severance of its nerves, it contracts suddenly and forcibly, to the extent of from one to two inches. This faculty adjusts it well to the flexions and erections of the spinal column, and thereby prevents injury. No such quality exists in the pia mater of the brain, as it is not required there.

SECT. II.—OF THE SPINAL MARROW.

Its general form is cylindrical, but flattened somewhat both behind and before. It departs also from the strict cylindrical shape, by being enlarged or swollen at particular points. One of these enlargements occurs in the neck (*intumescentia cervicalis*), where the spinal canal is formed by the five lower cervical vertebræ, and the roots of the axillary plexus of nerves are given off. The enlargement is in the transverse direction or axis of the spinal marrow, but not so much in its thickness, and terminates gradually both above and below. The medulla spinalis afterwards continues small, with very slight undulations or nodosities, until within three or four inches of its lower extremity, when it again enlarges. The enlargement here (*intumescentia lumbalis*), though sufficiently obvious, is not equal in actual magnitude to that in the neck, and is the place from which all the lumbar nerves and the three superior sacral proceed. It is then brought gradually to a point somewhat blunted (*conus medullaris*), which most commonly does not descend below the first lumbar vertebra.[1] The point is, in some rare cases, bifurcated, and by a transverse fissure converted into a tubercle.

The spinal marrow, besides terminating so much above the lower end of the spinal canal, is much smaller in its diameter, even with the addition of its membranes, than the canal. This circumstance prevails, especially in the neck, and in the loins, where much motion is experienced, and, consequently, a provision is thus made against any injury to it from pressure.

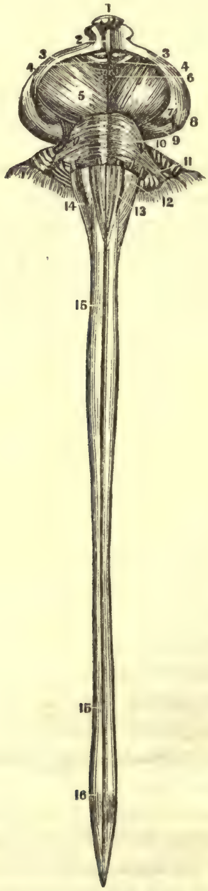
The Medulla Spinalis is marked off, longitudinally, into two symmetrical parts, by one fissure in front and another behind, both of which extend its whole length, and are placed exactly in its middle. The contiguous edges or surfaces of each of these fissures adhere so, that it re-

[1] The Spinal Marrow at the third month of the embryo extends to the end of the coccyx; it then suddenly contracts to the second lumbar vertebra. The coccyx is cotemporaneously reduced from seven to four pieces. Serres.

quires a slight maceration or dissection to render them evident. The posterior fissure is decidedly deeper, especially at its upper part, than the anterior: but the latter, in return, is somewhat broader. The difference in depth, however, is variable, as subjects are frequently met with in which it is not appreciable.

Moreover, on each side of the medulla spinalis there is a lateral fissure. It is not precisely in the middle, but somewhat posterior, and penetrates inwards and forwards. In many instances it is merely a simple superficial depression, much less deep than either of the former. It does not run the whole length of the medulla spinalis, but terminates somewhere in the upper part of its thoracic portion by joining

Fig. 264.

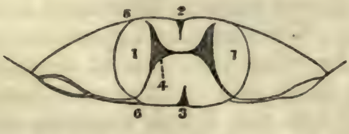


Anterior view of the Spinal Marrow, Medulla Oblongata, &c., of a new-born infant.—1. The pituitary gland. 2. The infundibulum. 3. The optic nerves. 4. The corpora albicantia. 5. Crura cerebri. 6. The triangular space between the crura. 7, 8. Origin of optic nerve. 9. Posterior portion of the thalamus nervi optici. 10. Pons Varolii. 11. Its prolongation into the crus cerebelli. 12. Eminentia olivaris. 13. Corpus pyramidale. 14. Corpus restiforme. 15, 15. Anterior middle fissure of the spinal marrow. 16. Enlargement for the origin of the lumbar nerves.

with its fellow after having converged regularly towards it.[1] The different opinions of anatomists on the existence of this fissure may be accounted for by its being readily found in early life, while it is obliterated or very indistinct in old age. This lateral fissure should be carefully distinguished from two others, one before and the other behind it, which extend the whole length of the medulla spinalis, and consist in a series of little depressions, running into each other and transmitting the filaments which form the roots of the spinal nerves. The posterior, of the last named lateral fissures, is deeper than the anterior, and penetrates in the same direction with the lateral fissure first mentioned; it also, in like manner, joins its fellow, but only after having proceeded to within a few lines of the inferior end of the medulla spinalis.

The substance of the spinal marrow being of two kinds, cineritious and medullary, the order of their position is reversed from what occurs in the brain; for the cineritious is included or enveloped by the other. On making a transverse section, the cineritious will be found much less abundant than the other, and consisting of a thin transverse vertical laminæ in or near the centre of the medulla spinalis: this part is joined at either end to a portion somewhat crescentic, whose concavity is outwards, and the convexity inwards. The transverse part does not run into the middle of the crescent, but somewhat anterior to the middle, so that the anterior horn is shorter than the posterior, and also thicker and obviously more obtuse. The cineritious or grayish substance is more abundant at the lower part of the medulla spinalis than it is above. In the fœtus, at the end of gestation, it predominates below, occasionally, to the entire exclusion of the other. Rolando asserts that in the spinal cord there are two kinds of cineritious matter, the one commonly acknowledged and which he calls *cinerea vasculosa;* the other, at the posterior horn of the cineritious crescent, is said by him to be perfectly gray, and which he calls *cinerea gelatinosa*, it being said to contain corpuscles similar to the red particles of frog's blood. The medullary or white substance is more abundant laterally than elsewhere, and has its two symmetrical sides joined together by a thin lamina at the bottom of the anterior and of the posterior fissure.

Fig. 265.



A transverse section of the Spinal Marrow.—1, 1. The two halves of the spinal marrow. 2. The anterior middle fissure. 3. The posterior middle fissure. 4. The position of the cineritious matter to each half of the spinal marrow. 5. The origin of the anterior root of a spinal nerve. 6. The origin of a posterior root with its ganglionic enlargement.

Each half or symmetrical side of the medulla spinalis is itself divided into two cords, marked off from each other by the posterior horn of the cineritious crescent, and by the first described lateral fissure. Of these

[1] Meckel, Manuel D'Anatomie.

cords the anterior is, consequently, much the larger; it is also longer, and forms the inferior extremity or the point of the medulla spinalis. The posterior cord, though so much smaller and narrower than the anterior, is itself subdivided into two, by a slight but well-marked split; of these last two cords, the one next to the posterior middle fissure of the medulla is smaller than the other. These arrangements, according to Meckel, are much more obvious in the early life of the human subject than afterwards; and are particularly conspicuous in the brute creation.

The thin white laminæ by which the two sides of the spinal marrow adhere to each other at the bottom of the middle fissures are called Anterior and Posterior Commissures. It is stated by Gall and Spurzheim,[1] that the Anterior Commissure is formed by transverse fibres or filaments, which adhere to one another from the opposite sides like a suture, or after a serrated fashion; whereas, the Posterior Commissure is formed by a band of longitudinal fibres. There is also another Commissure, called Middle or Cortical, from its position. It is formed out of the transverse part of the grayish or cineritious substance.

The cords which form each half of the medulla spinalis are differently disposed: the posterior continues on the side to which it specially belongs, while the anterior, having got within the circumference of the first cervical vertebra, crosses over to the opposite side by decussating with its fellow. This decussation occupies the space of four or five lines, and interrupts, for that distance, the middle fissure in front of the medulla. It is not effected by the cords passing in mass from one side to the other, but each cord sends off four or five fasciculi, which are interwoven with their congeners, like the fingers of the two hands when interlocked obliquely. It is to be observed that the whole body of the anterior cords is not subjected to such distribution; for the fasciculi just described come from their anterior and from their posterior faces, while the intermediate part is permitted to pursue its course straight upwards. This decussation, upon which so much interesting physiological speculation depends, has been known for the last century or more, and is spoken of by Mistichelli and Petit. There are other places where the fasciculi of the spinal marrow seem to cross from one side to the other, but the fact is not yet verified sufficiently.

The existence of canals in the spinal marrow has been from time to time announced;[2] though authors differ much in the accounts of their position and extent. When such an appearance is presented, it is supposed, by some, to be either the result of disease or of accident, with the exception of a small one eight or nine lines long, which communicates at one end with the fourth ventricle, and is shut up at the other.[3] This canal is a vestige, in the human subject, of the complete separation of the spinal cord which occurs in the lower Articulata, and almost occurs in fishes.

The spinal marrow of a child is very easy to divide by tearing it into threads, running its whole length; these threads do not seem to have any determinate number, but to be regulated by the healthy con-

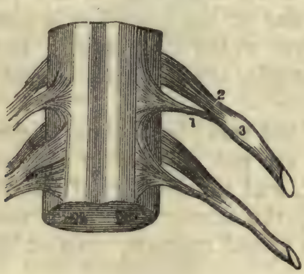
[1] Recherches sur la Syst. Nerv. &c. Paris, 1809.
[2] Gall, Portal, Morgagni, Stilling.
[3] Meckel, p. 605, vol. ii., Bichat, vol. iii. p. 128.

sistence of the spinal marrow, and the patience with which the process is pursued. If a spinal marrow has been macerated for some years in spirits, it may be broken or split up into radii, or segments, running from the centre to the circumference, like a tree; and these sections may be divided into thin, short, flat laminæ adhering to, or anastomosing with, such as are contiguous to them. Müller found a similar arrangement in the spinal marrow of the Petromyzon Marinus, though he has never seen it in any other animal.

Spinal Nerves.—The spinal marrow sends out from its sides thirty pairs of nerves, which, like the vertebræ, are arranged into cervical, dorsal or thoracic, lumbar and sacral. Of these there are eight cervical, one of which, from its escaping between the occiput and the first vertebra, is most usually designated as sub-occipital; and therefore the number of the cervical nerves is reduced to the same with that of the vertebræ, to wit, seven. There are twelve pairs of dorsal nerves, five of lumbar, and five of sacral. Occasionally, there is a sixth sacral nerve on each side, which augments the number of spinal nerves to thirty-one pairs.

Every spinal nerve is formed from two roots on the same level, one before and the other behind, and each root consists in several fasciculi of nervous matter. The front root arises from the anterior cord or part of the medulla spinalis, and the other from the posterior cord.

Fig. 266.



A view of a small portion of the Spinal Marrow, showing the Origins of some of the Spinal Nerves.—1. The anterior or motor root of a spinal nerve. 2. The posterior or sensory root of a spinal nerve. 3. The ganglion connected with the latter.

The posterior root is larger than the anterior, but has fewer fasciculi in its composition, and is not so filamentous. The two roots are kept asunder by the Ligamentum Denticulatum. The fasciculi of each are slightly connected by a loose delicate cellular substance, and as they are about penetrating the dura mater, each fasciculus collects into a single cord, which passes the dura mater through its appropriate foramen. In this way the anterior and posterior roots are kept distinct till they have got to the outside of the membrane mentioned; but the foramina, through which they pass, border closely upon one another. The posterior root then forms a ganglion of a round or oval shape; from whose external extremity there proceeds a single nervous trunk, which is joined immediately at its commencement by the anterior root.

The central ends of the spinal nerves, according to Valentin, do not terminate with the spinal cord, but, having joined it, ascend into the

brain. The nerves below ascend directly upwards, but the higher ones pass inwards towards the centre of the cord, almost to the gray substance, and are then directed upwards to the brain. In the white substance of the medulla spinalis, the nervous fibres are in contact, but upon the borders of the gray substance they are intermixed with its globules. Being subsequently dispersed in the brain, they form loops in the cortical substance; and terminate in that way by mutual junction.[1] It is much doubted whether this ascent of the nerve-root is so general as asserted by Valentin, inasmuch as, under that arrangement, the medulla spinalis would increase constantly in size upwards. It is even denied by Stilling and Wallach that the roots ascend at all. The probability is that they do ascend some distance, and some may possibly get to the encephalon.[2] The roots of the nerves, according to Stilling and Wallach,[3] in both their Anterior and Posterior fasciculi, may be traced to the horns of the cineritious crescent, and make an intertexture among them. The same authority asserts that the filaments of the anterior and posterior fasciculi run into one another, and also cross into the roots of the other side. The fibres of each of the four roots are thus continuous with the fibres of the other three. Their connection with the ganglionic globules is the more likely, inasmuch as the cineritious crescents everywhere contain caudate nerve-vesicles, now ascertained to have a direct junction with the tubular nerve-fibre.

With the exception of the ganglions of the sacrum, which are in the spinal cavity of that bone, these bodies are placed in the intervertebral foramina. The size of the ganglion is generally proportionate to that of the nerve from which it proceeds, but not invariably so, as some of the sacral ganglia are in small excess over the size of their nerves.

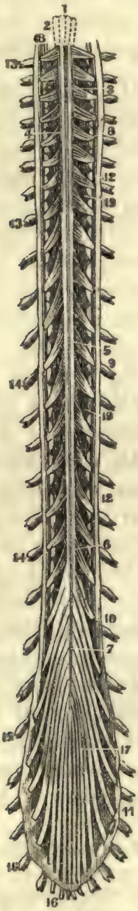
The two nerves of the same pair, though generally symmetrical, or precisely resembling, are not constantly so; sometimes one is placed higher than the other, and the number of the fasciculi may be greater or less. The roots of the nerves are much nearer, or cluster more at the extremities of the spinal marrow, than at its middle.

The Cervical Pairs of Nerves are nearly horizontal in their course from the medulla spinalis to the foramina in the dura mater. The first one, or the sub-occipital, is strictly so; the others incline very gradually more and more downwards. They have, therefore, but a very short passage before they reach the intervertebral foramina. Their roots are so pyramidal that the bases nearly touch each other, and, for the most part, are connected by an anastomosing filament, which goes from the upper margin of the nerve below, to the lower margin of the nerve above. These anastomoses, connecting the lower fasciculi with the upper, are both on the anterior and posterior cords of the medulla, but more uniformly as regards the latter. Modifications of this arrangement, which it is unnecessary to specify, are met with in different subjects.

[1] Müller, p. 655.
[2] See Principles of Human Physiology, by Carpenter, p. 266, for the arguments.
[3] Sharpey and Quain, Anat. vol. ii. p. 230.

The Dorsal or Thoracic Pairs are much inferior in size to any other nerves, except the inferior sacral. Anastomosing filaments do not generally prevail, yet they are found occasionally, as in the neck, upon the two or three upper pairs. The first one has the broad pyramidal or triangular root of a cervical nerve, and resembles it also in volume. The second is the smallest of any; they then go on increasing in size to the lowest, but not in uniform gradation. They are successively more oblique, and consequently longer from their bases to their passage through the dura mater.

Fig. 267.



Posterior view of the Spinal Marrow. The dura mater is here split open, and its cut edge is seen; also the manner of its perforation by the roots of the nerves, their ganglions being exterior to it.—1. Inferior extremity of the medulla oblongata. 2. The calamus scriptorius. 3, 4, 5, 6, 7. The posterior face of the spinal marrow, with the middle fissure. 8, 9, 10, 11, 12, 13, 14, 15, 16. Ganglia on the posterior roots of the cervical, dorsal, lumbar, and sacral nerves. 17. Cauda equina. 18. Upper end of dura mater.

The Lumbar and the Sacral Pairs arise closely upon each other, indeed in absolute contact successively, from the lower end of the medulla spinalis, and form a cluster of filaments resembling the tail of a

horse; hence it is called Cauda Equina. As their place of origin is within the precincts of the first lumbar vertebra and the two or three last dorsal, they all observe a very descending course in their progress to the intervertebral foramina, and the lower ones are almost vertical. Notwithstanding they are in contact, and adhere by a loose cellular substance, yet there are no anastomosing filaments between the adjacent roots. From the sacral ganglia presenting the peculiarity of being situated in the spinal cavity of the sacrum, instead of in the foramina, the single nerve formed from the ganglion and the anterior fasciculus, has to proceed a distance more or less considerable in the sacral canal before it can escape from it.

Of the Ligamenta Denticulata.

These bodies are narrow, semi-transparent bands, and very thin, which are placed one on either side of the medulla spinalis, between the pia mater and the tunica arachnoidea. They commence at the occipital foramen, by an adhesion to the dura mater, and, descending between the anterior and the posterior fasciculi of the roots of the nerves, terminate somewhat above the inferior extremity of the medulla spinalis.

Each one is, at its commencement, in front of the accessory nerve, and in descending is rather nearer to the posterior than to the anterior fasciculi. By its internal margin it adheres with a uniformity somewhat interrupted by fissures, to the pia mater; but the external margin has a very different arrangement, for it sends off at intervals from twelve to twenty-four serrated or denticulated processes, which for the most part are placed between the fasciculi of cervical and of dorsal nerves. The extremities of these teeth are small, rounded and strong, are surrounded by the arachnoidea, and adhere very firmly to the dura mater, being pointed downwards. The position and connections of each ligamentum denticulatum are such as to make it serve as a fastening; which use is additionally indicated by its fibrous texture, and by the necessity that the medulla spinalis has for such fastening, in consideration of its being so deficient in filling up the vertebral canal.[1]

It is taught, by many anatomists, that the ligamenta denticulata, from the opposite sides, join at the lower end of the spinal marrow to form the single cylindrical cord (*central ligament*) that passes thence to the lower end of the spinal cavity, and has been described as an emanation from the pia mater. I am, however, induced to think, with Meckel and others, that general analogy is in favor of the latter.

[1] An opinion has been advanced by Professor Pancoast that the pia mater of the elephant, of the bullock, and of man, forms by its duplicature the ligamentum denticulatum. The specimens of the former which I have seen in his possession afford strong indications of that arrangement: at the same time, in examining its point of origin in man from the dura mater at the foramen magnum, its distinctly fasciculated and tendinous character there is in opposition to this conclusion: the fissures which separate it along its internal margin from the pia mater are also not favorable to this idea, which in other respects is plausible and ingenious.—Wistar's Anat. vol. ii. p. 513, Phila. 1839.

SECT. III.—OF THE BLOOD-VESSELS OF THE MEDULLA SPINALIS.

The arteries of the Spinal Marrow are derived from the Vertebral, Intercostal, Lumbar, and Sacral Arteries.

1. The Posterior Spinal Artery (*arteria spinalis posterior*) is the lowest branch of the vertebral which is given off in the cavity of the cranium. It reaches, soon after its origin, the posterior face of the Medulla Spinalis, and runs to the lower extremity of the latter, on the side of its posterior fissure. Its course is parallel with its fellow, and very serpentine. In its descent, it is continually reinforced by small branches which get into the spinal cavity through each of the intervertebral foramina, they being twigs from the Vertebral, Intercostal, Lumbar, and Sacral Arteries. It makes numerous transverse anastomotic connections with its fellow.

2. The Anterior Spinal Artery (*arteria spinalis anterior*) arises above the last from the vertebral. Shortly after its origin, it unites with its fellow into a common trunk, which descends along the anterior fissure of the medulla spinalis, but is subject to interruptions and to turns right and left. It also is reinforced by twigs from the same arteries that pass into the spinal cavity through the intervertebral foramina. In its whole course it sends off branches from each side to the medulla spinalis.

The Cauda Equina is supplied by arteries from the Lumbar and from the Sacral Arteries which reach it through the foramina, between the lumbar vertebræ and in the sacrum.

The Veins of the Spinal Marrow are very abundant. A large one on each side of the middle line, being at the edge of the posterior vertebral ligament and called the Sinus Columnæ Vertebralis, is situated in the spinal cavity, on the posterior face of the bodies of the vertebræ, between their ligamentous covering and the dura mater. They are the general recipients for the blood of the contiguous structure. They detach a considerable number of branches, which run transversely, and anastomose with one another on the body of each vertebra, so that each vertebra has its little system of anastomosing branches. These links constitute the Circelli Venosi. The anastomoses communicate with the intercostal veins, and, indeed, with all such as are on the outside of the spinal column, by means of small branches that get out by the intervertebral foramina. They receive the veins from the bodies of the vertebræ, and from the dura and pia mater of the spinal marrow.

The two sinuses may be traced as low down as the inferior end of the sacrum, where they arise by small trunks from the fatty matter which surrounds the lower end of the cauda equina. When their size is somewhat augmented by their ascent, they communicate by a large

transverse branch. The superior end of each sinus terminates by several anastomoses with the vertebral vein, and with the anterior occipital sinus, through the latter of which its blood is finally carried into the lateral sinus. For a further account, see Sinus Vertebrales.

CHAPTER II.

OF THE ENCEPHALON, OR BRAIN.

By this term is designated that section of the central portion of the nervous system which is contained within the bones of the cranium. In its general configuration it differs materially from the medulla spinalis, in being spheroidal or oval.

The Encephalon is formed by cineritious and medullary matter, and, as a mass, consists of four distinct portions: the Medulla Oblongata, which is in continuation of the spinal marrow, or its superior part; the Protuberantia Annularis, or Pons Varolii, which is placed at the upper extremity of the Medulla Oblongata; the Cerebrum, which occupies six or seven-eighths of the cavity of the cranium; and the Cerebellum, which lies upon the posterior fossæ of the base of the cranium. As the brain is a double organ, each of these parts is symmetrical, or consists in right and left halves perfectly alike.

It is surrounded by a continuation of the same membranes with the medulla spinalis: to wit, the Dura Mater externally, the Tunica Arachnoidea next, and the Pia Mater internally.

SECT. I.—OF THE MEMBRANES OF THE BRAIN, OR ENCEPHALON.

Of the Dura Mater.

This membrane, the most superficial of the three belonging to the encephalon, lines the whole internal face of the cavity of the cranium, and is attached with great tenacity to it, particularly in early life, from which cause it is to be considered also as an internal periosteum.

Its external surface has a rough unequal appearance, and adheres much more strongly where the sutures exist than on the other surface of the bones, owing to its detaching many large filaments, which penetrate into the sutures and reach to the pericranium. Its adhesion to the surface generally of the bones is accomplished by fine filaments of fibres, and by very numerous and small blood-vessels, which become evident from the dots of blood collected upon it, when the bones are torn up, as in the usual manner of examining the head.[1] To the base of the cranium, its adhesion is still stronger, owing to the abundance of the foramina and fissures there; to the margin of each one of the foramina it is fixed with extreme compactness, and may be considered as continuous there with the adjacent pericranium.

[1] See Meningeal Blood-vessels.

The Dura Mater consists of two laminæ, one within the other; they, however, are attached so closely in the greater part of their extent, that it requires the knife, or strong artifical force, to separate them. Sometimes, in tearing off the skull-cap of a middle-aged person, the external lamina is brought away with the bone.

Several processes arise by duplicature of the internal lamina of the dura mater, and extend from the circumference towards the centre of the cavity of the cranium. They are as follows:—

The Falx Cerebri separates the hemispheres of the brain, and is consequently precisely under the middle line of the head. Its shape is well indicated by its name. It commences by a small point from the middle of the body of the sphenoid bone, and continues to arise along the crista galli, the crest and middle line of the frontal bone, the sagittal suture and the upper limb of the occipital cross, till it reaches the internal occipital protuberance. It is about an inch broad in front where it begins, but it increases continually, though gradually, in breadth till its termination, where it is two, or two and a half inches wide. It is strongly fastened along the crista galli, and at the foramen cœcum, and being also fastened behind to the tentorium (with which it is continuous), as well as along the intermediate points of bone, it is kept in a state of strict tension, which does not admit of its wavering to one side or to the other. Its inferior margin is very concave, and goes to within a small distance of the corpus callosum. There are sometimes considerable apertures in it, through which the flat surfaces of the hemispheres come into contact.

The Tentorium Cerebelli, another process of the internal lamina of the dura mater, is placed transversely across the posterior part of the cranium, and separates the cerebellum from the posterior lobes of the cerebrum. It is continuous with the posterior end of the falx major, whereby these two processes exercise a mutual tension. The tentorium is, therefore, kept convex above and concave below.

Its form is crescentic; its outer circumference is extended along the horizontal limbs of the occipital cross, and along the superior angle or margin of the petrous bones to the posterior clinoid process. The internal circumference is much smaller and unattached, and being placed immediately behind the sella turcica, it leaves an opening (*foramen ovale*) which is nearly of the same size with, and occupied by the tuber annulare and the crura cerebri. The anterior extremities of the crescent are continued from the posterior clinoid process on each side, to the anterior, so that a deep depression is formed for lodging the pituitary gland.

The Falx Cerebelli is a small triangular process of the dura mater, which extends in the middle line from the under surface of the tentorium to the posterior margin of the occipital foramen. Its base is above, and its point below: the latter terminates by a small bifurcation. It adheres by its posterior margin to the middle inferior limb of the occipital cross; the anterior margin is free, and serves to separate the two hemispheres of the cerebellum.

The Dura Mater is essentially white fibrous matter, as is sufficiently

evident at whatever point it may be examined. These fibres have no settled course, but cross each other in every direction. It is white, sufficiently transparent for the vessels of the pia mater to be imperfectly seen through it, and almost inelastic. Its internal face is smooth and polished, and is covered or lined by the tunica arachnoidea, the halitus from which gives it a slippery feel. It is insensible to common excitants, such as cutting, or even cauterizing it; from which circumstance, together with the common inability of anatomists to trace nerves into its structure, it is supposed, by many, to be entirely destitute of them. The learned Chaussier, however, takes a different position in regard to these points, and says that it has sensibility, and that though none of the cerebral nerves can be traced into it, yet, by attentive examination, it is found that filaments from the sympathetic nerve follow the ramifications of its middle or great artery.[1] Bidder has also traced filaments of the trochlearis to the lateral sinus in the tentorium.

Meningeal Blood-Vessels.—The Dura Mater, on its exterior surface, is strongly marked by the meningeal arteries and veins, which creep and ramify through it, and make, as mentioned elsewhere, corresponding furrows in the bones. It is well supplied with such blood-vessels. The arteries are derived principally from the branches of the internal maxillary of either side, which get into the cranium through the foramen spinale and ovale of the sphenoid bone. There are branches also from the ethmoidal, the inferior pharyngeal, and the vertebral. The branch of the internal maxillary, called meningea magna, divides into two, of which the anterior being the more considerable, gains the anterior and inferior angle of the parietal bone; but the other is directed backwards across the squamous portion of the temporal. Each of these branches is subdivided into a considerable number of smaller ones, which for the most part incline diagonally backwards, in observing the course marked out by the furrows on the flat bones of the cranium. When the ramifications become small, they then cease to impress the bones, because they are more buried in the substance of the dura mater, but the larger branches jut out prominently upon its surface exteriorly. The capillary terminations are supposed by Bichat to be in small number comparatively, and to be limited principally to those of nutrition.

Some of the veins accompany the arteries, as in other parts of the body, and where they are in contact with them, are flat, or bent around the arteries so as to look like an investment of them, or like an extravasation of injecting matter. They empty into the sinuses and emissaries about the base of the cranium. Others are free, and discharge into the proximate sinuses. All of the intrinsic veins, as they may be called, are small. In the case of both arteries and veins, there are, however, very frequent anastomoses with the blood-vessels of the diploic structure of the cranium, and with those of the integuments. The dura mater has a few lymphatics going in company with its blood-vessels.

Of the Sinuses of the Dura Mater.—The sinuses are large cavities placed between the two laminæ of the dura mater, and receive the blood from the veins of the pia mater, also to some extent the intrinsic

[1] Exposition de l'Encéphale, p. 29.

veins of the dura mater itself, as just stated. They are formed by the separation of these laminæ, and are lined by a membrane corresponding with the internal coat of the veins.

1. The Sinus Longitudinalis Superior extends along the whole base of the falx cerebri, from the ethmoid bone to the tentorium, where it terminates in the lateral sinuses. It begins at the foramen cœcum in a small pointed manner; and, according to some anatomists, by a small vein, which passes from the nose through this foramen; it is successively increased in size from before backwards, and is of a prismatic shape. One side of the prism is upwards, and, of course, is formed by the external lamina of the dura mater; while the other two parietes are lateral, and are formed by the duplicature of the internal lamina. Its cavity presents a small number of cords, round or flattened, passing from one side to the other; they are called Chordæ Willisii or Trabeculæ, and prevail principally at its back part.

The longitudinal sinus receives on each side from ten to twelve large veins, which bring the blood from the pia mater. Those from the convex surface of the brain are joined, just before entering the sinus, by such as belong to the flat side of the hemispheres. These veins enter the sinus, for the most part, obliquely forwards, or in a manner opposed to its circulation. They are also furnished with valves, which circumstance, besides their oblique entrance into the sinus, is a provision against their being filled by the regurgitating blood. The most posterior ones previously glide eight or ten lines between the laminæ of the dura mater, and are somewhat tortuous. This sinus also receives several veins from the bones, and some from the scalp, which traverse the bones at different places: among the largest of them are those that come through the parietal foramina. The dura mater itself sends some of its veins into this sinus.

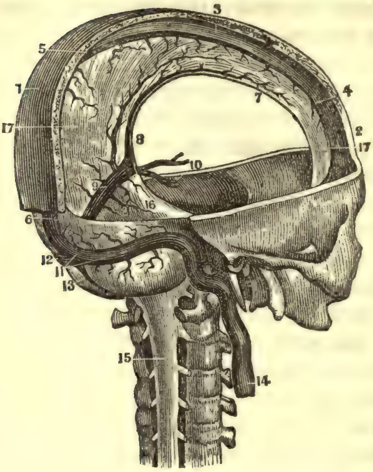
In the longitudinal sinus, towards its posterior part, is found a considerable but variable number of small granular bodies; some in clusters, others insulated, and from the size of a pin's head to a line or more in diameter. They are the Glands of Pacchioni. These bodies are also to be found on the surface of the dura mater near the sinus; some of them, indeed, make foramina through the dura mater, and corresponding depressions into the skull. One on each side, larger than usual, and near the parietal foramen, is remarkable for this.

2. The Sinus Laterales, one on each side, are situated in the base of the tentorium, and follow its course along the grooves of the occipital and parietal bones. They then leave the tentorium, and go along the groove in the mastoid portion of the temporal bones to reach the posterior foramina lacera, where they terminate in the internal jugular veins. Their shape or circumference is ovoidal, instead of prismatic, as the longitudinal sinus is; they are also larger than it.

The sinus of the right side is very frequently larger than that of the left, and seems to be more a continuation of the superior longitudinal sinus. In some rare cases one of these sinuses is deficient.

The lateral and the inferior veins of the cerebrum, and the inferior veins of the cerebellum, run into the lateral sinuses.

Fig. 268.



A view of the Dura Mater of the Cranium and part of the Spinal Canal, with the Sinuses.—1, 2. A section of the bones composing the vault of the cranium, showing the arched attachment of the falx major. 3, 4. Anterior portion of the superior longitudinal sinus. 5. Its middle portion. 6. Its inferior portion; the inferior part here of the cranium is removed. 7. Commencement of the inferior longitudinal sinus. 8. Its termination in the sinus quartus. 9. The sinus quartus or rectus. 10. The venæ Galeni. 11. The right lateral sinus. 12. The torcular Herophili. 13. The sinus in the falx cerebelli. 14. The internal jugular vein. 15. The dura mater of the spinal marrow. 16. The tentorium cerebelli. 17, 17. The falx cerebri.

3. The Sinus Longitudinalis Inferior is situated in the falx cerebri just above its concave edge. It is much smaller than the superior, and terminates behind in the sinus quartus. It receives the veins of the falx, and a few from the corresponding flat parts of the hemispheres.

4. The Sinus Quartus, or Rectus, is situated in the tentorium, where the latter is joined by the falx major or cerebri. It is triangular or prismatic, and runs from the anterior margin of the tentorium to the posterior, where it terminates in the extremity of the longitudinal sinus. The general union which is there formed between the longitudinal, the fourth, and the lateral sinuses, constitutes the Torcular Herophili.

The anterior extremity of the fourth sinus, besides receiving the inferior longitudinal, is joined by the Vena Galeni, a single trunk, formed by the junction of the two veins of the middle of the velum interpositum, and extending from the posterior margin of the fornix to the beginning of the sinus quartus. The Sinus Quartus, in its course, also receives the superior veins of the cerebellum, with the exception of the most anterior ones, which terminate in the Vena Galeni.

5. The Sinus Petrosi are small cylindrical cavities, and are so called from being situated on the petrous bone. There are two on each side; one above and the other below. The former is the Superior Petrous Sinus, and runs from the cavernous sinus along the superior margin of the petrous bone to join the lateral sinus, where the latter quits the tentorium to descend towards the base of the cranium. The other Petrous Sinus is the Inferior. It is larger than the superior, and

arises, also, from the cavernous sinus by its posterior margin. It then runs along the fissure between the occipital and the petrous bone, leaving its mark on the margin of these bones, but principally on the former, and then terminates in the lateral sinus just above the posterior foramen lacerum.

6. The Sinus Cavernosi, one on each side, are also formed by a separation of the two laminæ of the dura mater, though their shape is so different from that of the others. They are situated at the sides of the sella turcica, and on the body of the sphenoid bone. Their cavity is very irregular, and is furnished with a number of filaments, which cross in every direction, and give it a cellular arrangement. The internal carotid artery and the sixth nerve traverse it, but are protected by its lining membrane being reflected over them.

The cavernous sinus anastomoses in front with the circular sinus, and behind with the two petrous sinuses and the anterior occipital. It receives, in front, the ophthalmic veins; from above, the anterior and inferior cerebral veins; and on the sides, some veins from the dura mater.

7. The Sinus Circularis is placed in the sella turcica, and surrounds the pituitary gland. It is a small cavity which receives the veins of this gland, and, as just mentioned, communicates with the cavernous sinus.

8. In the posterior part of the base of the cranium, there are also some other sinuses, called, from their position, Occipital. One of these, the *Anterior*, is upon the basilar process of the os occipitis, and extends itself directly across the bone, from the hind part of one cavernous sinus to the corresponding point of the other; and is, therefore, a means of communication between these two cavities. Another of these sinuses, the *Posterior*, extends from the region of the Torcular Herophili, or the upper extremity of the lateral sinuses, along the base of the falx cerebelli, to the posterior margin of the occipital foramen, where it bifurcates, and then goes along the margin of this foramen to discharge itself into each lateral sinus at the posterior foramen lacerum.

The smaller sinuses about the base of the cranium, besides the outlets mentioned, have collateral ones, which pass at different places through the base of the cranium, and run into the branches of the internal jugular vein. These communications, as mentioned in the account of the veins, were known to Santorini, and are called his Emissaries.

Of the Tunica Arachnoidea.

This is a well-marked serous membrane, and the second of the envelops of the brain. It is spread over the surface of the pia mater, adhering to it closely in the greater part of its extent. It is so diaphanous and thin, as its name implies, that it is distinguished with some difficulty, wherever it adheres to the pia mater; which it does all over, with the exception of a few places on the basis of the brain, as, for example, just in front of the tuber annulare, and behind the medulla

oblongata. There this membrane may be seen stretched from one prominence to another, and separated considerably from the pia mater. It does not dip into the fissures of the brain, but goes directly across them, from the ridge of one convolution to that of the adjacent, so that it is entirely smooth and uniform in its distribution. Notwithstanding the general closeness of its connection with the pia mater, it may yet be separated from it by careful dissection, by slight maceration, or by the use of the blowpipe. Dropsical effusions frequently make out the distinction between the two membranes; also the deposit of coagulating lymph.

Considering this membrane as a single layer, we have to speak of the dura mater, as lying loosely upon it. But the authority in the first instance of Bichat, sanctioned by the testimony of many other anatomists, has assigned to it a much more considerable extent. For it is well ascertained, both by analogy and by observation, that it is a sac, which, besides covering the external surface of the pia mater, is reflected over the internal surface of the dura mater, and gives to the latter its smooth shining appearance.[1] This lining is on the same principle that the serous lamina of the pericardium lines its fibrous lamina, or that the synovial membrane lines the ligamentous attachments of an articulation. In the early periods of life, it may be separated from the dura mater by dissection, and it occasionally happens in the adult that its adhesion to the dura mater is so loose that it may be raised off in a broad layer, even without the use of a knife. Vicq D'Azyr has related a case in which it was detached by a collection of pus. Its places of reflection to the dura mater are on the basis of the cranium, where the blood-vessels and nerves pass into the sheaths formed by the dura mater, and along the blood-vessels entering into the sinuses. This membrane is continuous with the tunica arachnoidea of the medulla spinalis.

The tunica arachnoidea is considered to pass into the ventricles of the brain by the same apertures that the pia mater does, but it is much less manifest there than elsewhere.[2]

The texture of this membrane is exceedingly delicate and fine. It is always found, in health, in a transparent state, and is not furnished with red blood-vessels, but nerves are considered by Purkinje to exist in it. It secretes a sort of halitus, or synovia, which facilitates the motions of the brain, and prevents it from adhering. Occasionally, this secretion is so much augmented as to constitute a genuine dropsy.

Of the Pia Mater.

The Pia Mater, or Tunica Cerebri Vasculosa, is in contact with the substance of the brain. It also is extremely delicate, but, unlike the last, is furnished with an immense number of blood-vessels, which go to or return from the brain, and are, in most subjects, so abundant that they give a florid appearance, at a little distance, to the whole mem-

[1] There are some excellent and unequivocal examples of this in the Wistar Museum, prepared by the author.

[2] As the ventricles of the encephalon are but fissures in its structure, this arrangement is in opposition to that of the fissures on the surface of the encephalon, and in fact may be doubted from its defective evidence, excepting in the case of the Velum interpositum.

brane. Its external face appears entirely smooth, owing to its being covered, and its processes cemented together, by the tunica arachnoidea; but its internal face exhibits these processes as penetrating to the bottom of the fissures of the brain; consequently, it is very unequal.

The Pia Mater covers the upper surface of the cerebrum with such uniformity as not to require a detailed description of it; where it sinks into the great fissure between the hemispheres, it adheres from the two sides just above the corpus callosum. On the basis of the brain, it penetrates deeply into the anterior fissure, or the Fissura Sylvii; is reflected over the inequalities of the brain, but never in such a way as to leave them; and secures the bottom of the third and of the fourth ventricle.

The distribution of the pia mater over the ventricles of the brain is more complicated than that over its periphery, and it may be remarked that this portion is called, by some anatomists, the Internal Pia Mater; that its texture is much more delicate and net-like; and that it adheres more closely to the subjacent parts. Being extended from the superior surface of the Cerebellum and of the Pons Varolii, it enters into the third ventricle, under the posterior margin of the fornix, by the large transverse fissure between the latter and the tubercula quadrigemina. By its course between the fornix and thalami, it constitutes the Velum Interpositum, or the Tela Choroidea of Vicq D'Azyr. The pia mater is also introduced into the inferior cornu of the lateral ventricles along the internal margin of the hippocampus major, at the side of the pons Varolii, and into the fourth ventricle from its bottom part.

The several plexuses of vessels found in the ventricles of the brain have for their basis the pia mater; which is there arranged into a great number of folds, some of them being longitudinal and others crossed. Their formation, according to the views taken of the development and growth of the brain by Tiedemann, depends upon the internal membrane of the brain contracting itself as it finishes the deposit of medullary matter called Centrum Ovale. The vessels of the plexuses are the arteries, which are spent upon the surface of the ventricles, and the veins derived from the same; the latter are much more numerous than the first.

The mechanism of the pia mater resembles closely that of the medullary membrane of the Bones, which is in conformity with the fact of there being so large a quantity of adipose matter in the Brain; the proportion being one-fourth of the solid constituents of the latter, according to the analysis of Vauquelin. This coincidence of chemical feature between the brain and common marrow is still more remarkable, reference being had to the difference of function exercised by the two.

Of the Structure of the Pia Mater.—The pia mater is commonly spoken of as a complete membrane, yet its structure is different from that of membranes generally, inasmuch as it is a net-work, the meshes of which are formed by arteries and veins, and the interstices filled up by a loose, weak, cellular substance. Bichat has very justly observed that the union with the tunica arachnoidea is solely on the part of this cellular substance; whereas, the union with the cerebrum

is confined to the vessels, which are extremely numerous and very small before they penetrate it, and appear as bloody points when we cut into the substance of the brain. The principal arterial trunks of the pia mater, being the internal carotids and vertebrals with their branches, are at the basis of the brain; these trunks divide into smaller branches, on the convolutions and in the fissures. The primary divisions again divide and subdivide into tubes not much exceeding the size of the capillary vessels. In this last state they enter the brain, and may be seen very readily, either by a fine injection, or by tearing up the pia mater.

Purkinjé is said to have traced nerves into it.[1]

Glandulæ Pacchioni.—The pia mater presents, along the course of the longitudinal sinus, an abundance of those small graniform bodies existing also in this sinus, and called Glands of Pacchioni. They beset the veins as they enter into the longitudinal sinus, and even follow them there, so that there is a chain of them from the surface of the pia mater into the sinus. They are frequently so abundant on the superior part of the hemispheres, near the great fissure, that they cause the dura and pia mater to adhere, as if from inflammation. It is the larger of this kind which produce absorption of the dura mater, and of the internal table of the skull. These bodies are also found, along with the pia mater, in the ventricles of the brain, as at the external margin of the plexus choroides, around the pineal gland, and at the bottom of the fourth ventricle.

The Glandulæ Pacchioni, wherever found, present a nearly similar appearance and structure, but varying much in size: they are generally in clusters, which repose on common bases. Anatomists differ much in their opinion concerning them. Bichat acknowledges his complete ignorance on the subject; Portal says that they are only congeries of vessels or of cellular bodies filled with fat. Meckel states that, as they are found especially in the later periods of life, and never before birth, and as they never exist in very great abundance, except in persons who have often experienced diseases of the head, and are not observed in any animal, so we are forced to consider them as morbific productions, and not, as Pacchioni conceived, glands whose excretory ducts opened into the ventricles of the brain and into the sinuses of the dura mater. They have no excretory ducts that have been discovered, and it is entirely uncertain whether any specific fluid is secreted by them. Valentin says they are formed of exudation-corpuscles at first, which finally become fibrous.

SECT. II.—OF THE MEDULLA OBLONGATA.

According to the usage of many authorities of the present day, who follow, in the account of the central parts of the nervous system, the order of their development in the human subject, and also of their appearance in animals, I shall describe the encephalon from below upwards instead of from above downwards. The preference thus shown is, perhaps, principally serviceable in fixing upon the mind the order

[1] See Serous Membranes.

of growth and appearance, which, according to well-established experiments, are exactly in the order of importance to life.

The Encephalon should indeed be studied from two points of departure, one from below upwards, so as to exhibit the succession of parts as they are built or evolved regularly one upon the other, starting from the upper end of the spinal marrow. This has the advantage of elucidating more fully the relative position of parts, and is best suited to finish off a course of study. The other point of departure is from above, and thence to proceed by a succession of slices downwards. In the dissecting-room, the latter is more convenient. A single brain will then do as it lies in the subject, but in the practical working there are many defects, which can only be remedied by recourse to the first plan. The real way to study the encephalon perfectly would be to have several specimens hardened in spirits of wine. The first dissections might then proceed from the vertex downwards, as indicated in the dissecting-room manuals and in many of the systems of anatomy; and the finishing dissection should be in the order here laid down. The celebrated dissections of Gall and Spurzheim, the principal idea of which was the expanding filamentous structure of the encephalon, from below upwards, laid the foundation of this latter order of description. Their names, once dominant in the schools, have from the mutability of things disappeared almost, but not without their value being felt in the science of anatomy by those who have observed its progress; while names much less tributary to its elevation have emerged in their place, and adopted their ideas without adequate acknowledgment.

The Medulla Oblongata, also called Bulbus Rachidicus, extends from the superior margin of the first cervical vertebra to the middle of the basilar process of the os occipitis. It becomes gradually larger as it ascends, is about an inch in length, and eight lines wide at its base. It is by no means so cylindroid as the medulla spinalis, but presents several risings and depressions on its surface.

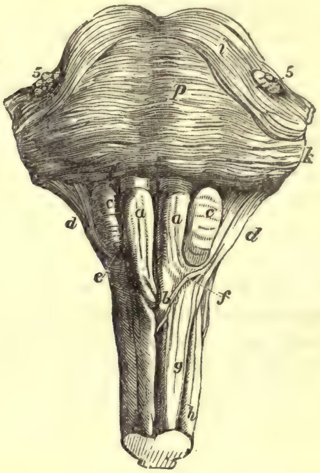
The under surface of the Medulla Oblongata is divided longitudinally by the middle fissure, a continuation of that on the front of the Medulla Spinalis. The fissure is two or three lines deep, which is rendered manifest by removing the pia mater. The Corpora Pyramidalia, or anterior pyramids, are placed one on either side of it, and are oblong bodies; being a continuation of the cords that decussate from the opposite sides of the spinal marrow. These bodies occupy the whole length of the Medulla Oblongata, increase in breadth as well as in elevation during their ascent, and are, lastly, somewhat constricted or diminished abruptly, where they join the Protuberantia Annularis or Cerebralis. Precisely at the latter point, between their bases, is a deep triangular pit, into which penetrates the pia mater. J. F. Meckel says that they are united at their lower extremities by a small transverse medullary Commissure of a line and a half in breadth. This junction is above the decussation of the cords from which the Corpora Pyramidalia arise.

The Eminentiæ Olivares are two bodies, one on either side, at the external margin of the corpus pyramidale. They are about seven lines long, two and a half wide, and are elevated to the height of one

line. The elevation ceases somewhat short of the annular protuberance, but their interior structure is continued into the latter, and may be traced into the thalamus nervi optici.

Like the pyramidalia, those bodies are medullary externally; but within, there is a nucleus of cineritious matter, called, from the irregularities of its margin, Corpus Fimbriatum, and which encloses some medullary matter. The corpus fimbriatum is open at the inner circumference,

Fig. 269.



An anterior view of the Medulla Oblongata.—*a*, *a*. Corpora pyramidalia, or anterior pyramids. *b*. Their decussation across the middle fissure. *c*, *c*. The eminentiæ olivares. *d*, *d*. Corp. restiformia. *e*. Arciform fibres. *f*. Fibres shown by Solly to pass from the anterior column of the cord to the cerebellum. They, I should think, are rare. *g*. Anterior column of medull. spinal. *h*. Lateral column. *p*. Pons Varolii. *i*. Its upper fibres. 5. Root of fifth nerve.

and has the medullary matter which it contains continuous there with the substance of the corpus pyramidale. Below, its circumference is continuous with the cineritious matter of the medulla spinalis. In the slight depression between the corpus pyramidale and the eminentia olivaris, are the roots of the hypoglossal nerve.

The Corpora Restiformia, or rope-like bodies, also one on either side, are placed at the lateral posterior margins of the medulla oblongata, just posterior to the eminentiæ olivares; and are readily brought into view by elevating the contiguous parts of the cerebellum. They are oblong risings of an inch in length; their lower extremities are in contact, and project where they begin to arise from the borders of the posterior fissure of the medulla oblongata; they then diverge, and extend forwards and upwards to terminate above in the cerebellum. Their margin next to the Calamus Scriptorius is by some called the Posterior Pyramid, and has been traced by Arnold and Burdach to the thalamus nervi optici of the cerebrum.

The corpus restiforme is formed of medullary matter, and is a continuation of the posterior cord of the medulla spinalis. From its superior posterior margin a thin medullary lamina about three lines square arises, and being sustained by the pia mater, advances to meet

its fellow, but does not absolutely touch it.[1] From the anterior end of each corpus restiforme, or rather the posterior pyramid, there departs a second process of medullary matter (*ligula*), larger and more thick than the preceding, and being covered by the roots of the pneumogastric and glosso-pharyngeal nerves, adheres to the Plexus Choroides of the fourth ventricle.

Calamus Scriptorius.—The superior face of the medulla oblongata is excavated between the corpora restiformia, in such a way as to present the outline of a writing pen, and is, therefore, called calamus scriptorius; which forms a considerable part of the floor of the fourth ventricle of the Brain, or the sinus rhomboideus. The fissure, in its middle, corresponds with the slit of a pen, the nib being downwards; and the fissure extends from the posterior fissure of the medulla spinalis, the whole length of the medulla oblongata. At the sides of this fissure and parallel with it, there are two rounded eminences somewhat grayish below and white above: they are called the *fasciculi teretes.* They pass along the back of the Pons and enter into the cerebrum.

The calamus scriptorius is marked by several streaks of medullary matter, which extend themselves transversely with a very slight degree of obliquity upwards, and reach the external margin of the corpus restiforme of the corresponding side. These medullary striæ present some varieties in regard to their volume, number, and arrangement. Sometimes they are slightly elevated narrow lines, which are perfectly distinct from each other, and from one to fourteen in number. On other occasions their volume is greater, but they are not so numerous. They generally extend, either one or all, from the middle fissure to the commencement of the auditory nerve, and are thereby part of its origin. Sometimes the anterior ones are directed towards the origin of the trigeminus nerve, but their union with it is not yet ascertained; the posterior ones are sometimes blended with the radical filaments of the pneumogastric nerve. The striæ themselves are sometimes interwoven or blended, and pass the boundary of the middle fissure to join with those of the other side. Their roots may be traced along the middle fissure, to the front or under surface of the medulla oblongata. If a medulla oblongata be well hardened in spirits of wine, and then torn open through its middle fissure, the surface thus exposed presents itself as formed almost entirely of the filaments just mentioned, running from back to front. In some cases I have seen them at their anterior ends pass on so as to form a superficial layer encircling the front of the medulla oblongata, like thread wound around a bunch of rods, and making the Arciform fibres. Santorini and Rolando have met with a similar arrangement. Meckel, whose observations on this subject are highly interesting, is disposed to consider the striæ not only as forming the roots of the auditory nerve, but as also related closely to the trigeminus and to the pneumogastric.

On the surface, also, of the fourth ventricle, or sinus rhomboideus, but in advance of the preceding striæ, there is another, on each side, still larger, which may be distinguished by its always beginning at some distance from the middle fissure. Its direction is transverse, and it passes just above the anterior extremity of the corpus restiforme, to

[1] It is called Pons Sinus Rhomboidei by J. F. Meckel.

run into, or to assist in forming, the root of the auditory nerve. Its existence is much more constant than that of the others. It is considered as an assistant ganglion to the auditory nerve, and in cases of deafness has been deficient. Being principally cineritious, it is called Fasciola Cinerea.

In tracing the continuation of the structure of the medulla spinalis into that of the medulla oblongata, we find that each of the anterior cords of the medulla spinalis, besides crossing with some of its fasciculi at the place mentioned, to wit, at the decussation of Mistichelli, and continuing their course upwards to form the corpus pyramidale, sends off a larger fasciculus, the intermediate, which ascends behind the eminentia olivaris, and forms the floor of the fourth ventricle, or sinus rhomboideus of the brain. There is yet another fasciculus of white matter, according to Rosenthal, between the others, into which the anterior column of the medulla spinalis is divided. He says that it touches the eminentia olivaris, surrounds it, and, after having traversed the annular protuberance, terminates in the tubercula quadrigemina.

The posterior cords of the Spinal Marrow, being continued into the corpora restiformia, becomes still more evidently divided into two fasciculi, from an increase of their volume, than they were in the vertebral canal. The internal of these fasciculi, the posterior pyramidal body, appears to stop, by a pointed termination, near the borders of the sinus rhomboideus, or fourth ventricle of the Brain, but may be traced, as stated, to the cerebrum; while the external is continued on through the annular protuberance to the cerebellum.

Stilling has ascertained that there are special deposits of ganglionic matter at the back of the medulla oblongata, which are connected with the roots of the spinal accessory, vagus, glosso-pharyngeal and hypoglossal nerves. They are visible on the surface of the calamus scriptorius.

SECT. III.—PROTUBERANTIA ANNULARIS.

The Annular Protuberance (*tuber annulare, protuberantia annularis, nodus cerebri, pons Varolii*) is the large projecting body, placed near the centre of the base of the encephalon, at the top of the medulla oblongata, and upon the junction of the body of the sphenoid bone with the basilar process of the os occipitis. It is convex, and about an inch in diameter, its transverse measurement being a line or two longer than the other. It is divided by a superficial fossa into two symmetrical halves, right and left.

When the pia mater is removed from the Protuberantia Annularis, the under surface of the latter is seen to be formed by transverse medullary fibres which come from the crura cerebelli. When these, which are commonly one or two lines in depth, are removed by scraping or cutting, a cineritious matter is exposed, which is traversed by numerous layers of medullary matter, also going in a transverse direction. About two lines deep from the surface of the protuberance, near the middle of each of its halves, are found some longitudinal medullary fibres con-

nected with cineritious matter, and which may be fairly traced as a continuation of the filamentous structure of the pyramidal bodies. These fasciculi, or filaments, passing on through the protuberance, are continued so as to form the under surface of the crura of the cerebrum.

Lying still deeper than the medullary fibres alluded to, there is an accumulation of cineritious matter, intermixed with perpendicular medullary layers situated one behind the other. Behind (or above when we stand erect) this intertexture, a small fasciculus (the cord described by Rosenthal) of medullary matter exists, which is a continuation of the intermediate fasciculus of the anterior medullary cord of the medulla spinalis, and may be traced afterwards to the superior face of the crus cerebri, where it terminates, as alleged by Rosenthal, in the Tubercula Quadrigemina. In connection with the same, a fasciculus is detached which is continued into the structure of the crus cerebri.

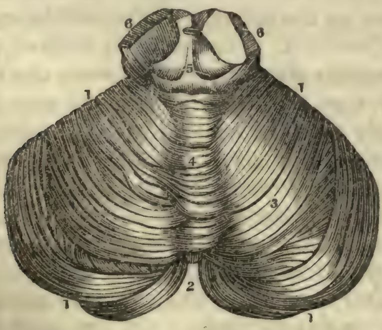
At the centre of the posterior margin of the Pons, we find sometimes an elongated triangular process, which penetrates deeply between the bases of the Pyramids, and may be traced to the posterior middle fissure of the Medulla Oblongata.

SECT. IV.—OF THE CEREBELLUM.

The Cerebellum, being placed in the posterior fossæ of the cranium, is separated by the tentorium from the posterior lobes of the cerebrum, beneath which it lies. It is connected with the Pons Varolii by a trunk of medullary matter on each side, called the Crus of the Cerebellum; and which is a root of the medullary matter entering into the composition of the pons.

It is of a rounded form, and well fitted to the cavity in which it reposes. It is convex above and below; measures about four inches in its transverse diameter, two and a half in thickness, and about the same from before backwards. The upper face is divided into two equal parts

Fig. 270.

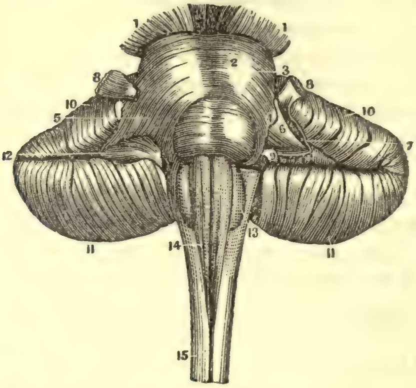


A view of the Superior Face of the Cerebellum.—1, 1. The circumference of the cerebellum. 2. The space between its hemispheres behind. 3. One of the hemispheres of the cerebellum, showing the laminæ which compose it. 4. The vermis superior. 5. The tubercula quadrigemina. 6. Section of the crura cerebri.

or halves, by a middle ridge, while the lower face is divided in the same way by a fossa, the *vallecula*. These halves are called hemispheres;

their surface is marked by many horizontal and transverse fissures or crevices, the edges of which are kept closed by the adhesion of the pia mater.

Fig. 271.



An anterior view of the Pons Varolii, the Cerebellum, the Medulla Oblongata and Spinalis.—1, 1. The crura cerebri. 2. The pons Varolii or tuber annulare. 3. Its middle fossa. 4. An oblique band of medullary matter sometimes seen passing from its side. 5. The external face of the crus cerebelli in its natural state. The line from 5 crosses the lobulus amygdaloides. 6. The corresponding portion on left side deprived of outer layer. 7. The nervous matter which united it to 4. 8. The trigeminus, or fifth nerve. 9. Auditory nerve. 10. The superior portion of the hemispheres of the cerebellum. 11. Inferior portion of hemispheres of cerebellum. 12. Lobulus nervi pneumogastrici. 13. Corpus olivare. 14. Corpus pyramidale. 15. Medulla spinalis.

The fissures are interposed between the laminæ or convolutions of the cerebellum, which, for the most part, converge towards its medullary trunk; the larger fissures are behind, while the shortest are in front near the annular protuberance. The pia mater penetrates to the bottom of these fissures, some of which, when exposed fully by its removal, are found to extend to the depth of an inch or more. One of these fissures which exists on the superior surface of the cerebellum, half an inch distant from the posterior and external margin of the latter, has a circular course, and is so well marked by its size and depth that it is called the Sulcus Superior Cerebelli. Another, situated under similar circumstances on the inferior surface of the cerebellum, is called the Sulcus Inferior Cerebelli. On the latter surface, also, there are two or three more of a middle size, situated between the sulcus inferior and the annular protuberance. These larger sulci have given occasion to anatomists to multiply most unreasonably the number of lobes of which the cerebellum consists. Bichat's mode of description is preferable: he says that, by cutting vertically through one of the hemispheres of the cerebellum, so as to expose the thickest part of its medullary matter, six or seven principal fissures will be seen, which, by penetrating to a considerable depth, divide the cineritious portion into as many converging parts. In the interior of these fissures there are much smaller ones, which pass at right angles to them. On the surface or periphery of the cerebellum, in the intervals of the larger fissures, there are many small ones, which, though nearly horizontal, terminate in each other by acute angles.

The superior middle ridge of the cerebellum, from its shape and position, is called, by Vicq D'Azyr, Vermis Superior; the anterior extremity of which, from its elevation, is the Monticulus Cerebelli.

The middle inferior part of the cerebellum, which presents the deep sulcus running longitudinally and forming the division into hemispheres, has a long ridge occupying the sulcus. This ridge is the Vermis Inferior of Vicq D'Ayzr, and is so concealed by the adjacent portions of the hemispheres, that a good view of it can be got only by removing the arachnoidea, the pia mater, and by pushing the hemispheres aside. The transverse fissures which penetrate it, and its general irregularity of surface, will then be sufficiently distinct. The pia mater and arachnoidea pass from the fore part of this body to the medulla oblongata, and thus assist in forming the floor of the fourth ventricle; which, without this reflection, would be exposed. The central part of the cerebellum, as formed by the vermis superior and by the vermis inferior, is the Fundamental Portion of Gall and Spurzheim.

At the root of the crus cerebelli are two small protuberances; the one above it, in the erect position, is the Amygdala (*lobulus amygdaloides*) or Tonsilla, from its resemblance to the tonsil gland; and the other being below is the Flocculus or Lobulus Nervi Pneumogastrici, from its contiguity to the pneumogastric nerve.[1]

The substance of the cerebellum is formed of cineritious matter externally, and of medullary matter internally. When a vertical section of it is made through the middle of one of its hemispheres, the medullary neurine or matter puts on the appearance of the thuya or arbor vitæ tree, the roots and ramifications of whose limbs, even to their smallest extremities, are surrounded by cineritious neurine or matter. In this view, there appears to be more cineritious than white matter; but when a horizontal cut is made from the periphery to the centre, parallel with one of the deep concentric fissures, the proportion of medullary matter seems to be much more considerable; and the arbor vitæ arrangement is proved to depend upon the laminæ of medullary matter radiating from the centre, or, in other words, from the massive medullary trunk in the interior of the hemisphere of the cerebellum. Each of these radiations commences by a root of considerable size, which divides and subdivides into branches. Each primitive radiation, as well as its branches, is covered by its own layer of cineritious matter about one line in thickness, and is kept perfectly distinct from the contiguous ones by the fissures which extend internally from the periphery of the cerebellum.

In the middle of the trunk of the arbor vitæ, exists the Corpus Rhomboideum, or Dentatum. It is an oblong rounded body, jagged and cineritious in its circumference, but medullary within. Its configuration resembles that of the corresponding body in the eminentia olivaris, with the addition of its being larger, and having its outline better marked. It is the ganglion of the cerebellum of Gall and Spurzheim.

The Central or Fundamental Portion of the Cerebellum exhibits also very clearly the arborescent arrangement, and is furnished with about seven primitive radiations, coming from a medullary trunk. The proportion of medullary matter to cortical, is less in it than in the hemi-

[1] In former editions these names were reversed, upon the authority of the time; the practice now is to apply them as here used.

spheres of the cerebellum. Each of the primitive radiations may be traced to some particular point or prominence on the surface of the fundamental portion, thus forming its basis; but this study is more curious than useful, though several anatomists have pursued it.

The Valve of Vieussens (*velum medullare, valvula cerebelli or cerebri*) arises from the cerebellum, just under the anterior part of the base of the monticulus, and runs obliquely upwards to terminate in the testes or lower part of the Tubercula Quadrigemina. Sometimes it is marked in its middle, by a longitudinal line or slight fissure, from either side of which proceed small lateral ones. It is principally medullary, and has a small quantity of cineritious matter at its extremities. It is thinner in the middle than at either of its margins.

Three medullary fasciculi, on each side, have now been assigned to the cerebellum; first, the Superior Peduncle, or the Valve of Vieussens (*valvula cerebelli*); the second is the Middle Peduncle or the Crus Cerebelli, which joins the Annular Protuberance; and the third is the Inferior Peduncle, it being the continuation of the corpus restiforme of the Medulla Oblongata. The superior and the inferior peduncle belong to the middle or fundamental portion of the cerebellum; they are consequently situated more internally, and are partially concealed by the crus cerebelli, and have interposed, between them and the latter, the Corpus Rhomboideum or Dentatum.

SECT. V.—OF THE CEREBRUM.

The Cerebrum weighs about three pounds, and is seven times as heavy as the cerebellum. It is ovoidal, and measures about six inches in its antero-posterior diameter, five inches in its greatest breadth, which is behind, and four or five in depth. It is separated above by a deep fissure (*fissura longitudinalis*), into two equal parts, called Hemispheres. At the bottom of this fissure, by parting the contiguous surfaces, is to be seen a broad lamina of medullary matter passing from side to side, and called the Corpus Callosum, which connects the two hemispheres together. The under surface of each hemisphere is subdivided into three lobes; Anterior, Middle, and Posterior.

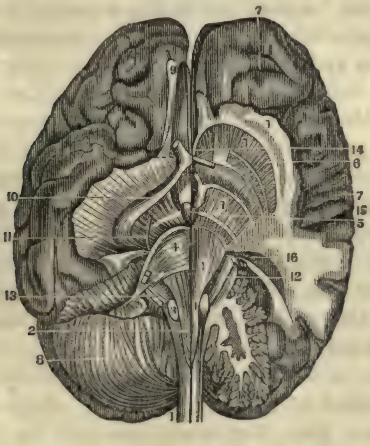
The Anterior lobes are placed upon the anterior fossæ of the base of the cranium; the Middle, upon the middle fossæ of the same; and the Posterior Lobes rest upon the tentorium. The two anterior lobes are completely separated by the Fissura Longitudinalis, which extends between them to the base of the cranium; the same is the case with the posterior lobes; the middle lobes have interposed between them the annular protuberance and the crura cerebri. When the pia mater is removed, the anterior lobe is seen to be marked off from the middle lobe by a deep sulcus, the fissure of Sylvius, in the under surface of the cerebrum, corresponding, in its position, with the posterior margin of the Lesser Sphenoidal Wing. At the internal root of the fissure is a bundle of medullary fibres (*fasciculus unciformis*) passing from the anterior to the middle lobe; and on spreading the fissure open is seen a prominence called the Island of Reil (Insula). The boundary between the middle and the posterior lobe is by no means well defined

on the basis of the brain, but it is agreed to consider as posterior lobe all that part of the hemisphere which rests upon the tentorium.

The periphery of the cerebrum is formed into convolutions (*gyri*), which give it an unequal tortuous surface, resembling the intestines of a small child. These convolutions are separated by fissures (*sulci*) of depths varying from an inch to two inches or more. The convolutions proceed in diversified and complicated courses, which never correspond in different individuals, and seldom exactly on the two hemispheres of the same brain. Though their summit is generally convex, yet some of them have it depressed slightly, which is considered a proof of each convolution being divisible into two halves or layers, placed side by side. Some of the convolutions are short, others long; they present numerous varieties in the manner of joining each other. Owing to the narrowness of the fissures between them, they are closely packed together, so that the lateral surfaces of each one are suited to such as are contiguous; occasionally, there is a departure from this rule.

The surface of the convolution, by which we mean not only the most

Fig. 272.



A view of the course of the Anterior Columns of the Spinal Marrow to their termination in the Hemispheres of the Cerebrum, after the dissections of Gall.—1, 1, 1, 1. The motor track traced out from the anterior column of the spinal cord to the hemisphere. 2. Corpus pyramidale. 3. Eminentia olivaris. 4. Pons Varolii. 5. The line from it traverses the left crus cerebri. 6. Corpus striatum. 7. Cineritious neurine of the cerebrum. 8. The cerebellum. 9. The olfactory nerve. 10. The optic nerve. 11. The fourth nerve. 12. The root of the fifth. 13. The seventh nerve. 14. Place of the anterior commissure. 15. A sulcus or fissure. 16. Back of thalamus.

exterior periphery of the cerebrum, but also the surface formed by the fissures to their very bottom, is covered by cineritious neurine or matter of about one or two lines in thickness.[1]

[1] From numerous observations, by Mr. Levret, on the brains of animals, it appears that the convolutions get their highest development in man, and especially those placed upon the outer or convex side of the hemisphere. An attempt has been made by Mr. Foville to arrange the locality and directions of the cerebral convolutions into somewhat like a systematic description of a very detailed kind; many of them start, according to him, at the Pons Tarini. It is true that everything having shape in the human body may be a subject of description, but it is also true that there are sound limits to the effort, which, if transcended, make it very fatiguing and very useless to the student. The anatomy of the encephalon has really no absolute termination, and from this cause has been very much overloaded with minutiæ.

Within the periphery of the cerebrum, the mass of medullary neurine or matter is very considerable, and is of an ovoidal shape. This ovoid is called the Centrum Ovale of Vieussens, and is brought into view by making a horizontal cut through the hemispheres, two inches below their summit.

In proceeding with the anatomy of the cerebrum from its base upwards, the following is the order or succession of parts in its structure: In advance of the pons Varolii, and springing from it, there are two divergent medullary trunks, one on each side, which run forwards, and are lost in the medullary substance of the cerebrum. These trunks are the crura cerebri. Upon the upper surface of each are two protuberances: the posterior is the thalamus nervi optici, and the anterior is the corpus striatum. Each crus cerebri, having penetrated into the substance of its respective hemisphere, expands by a multiplication of the filaments composing it, so as to constitute the principal bulk of the hemisphere. These filaments may, indeed, be traced very satisfactorily in almost every direction towards the periphery of the cerebrum, where they terminate in the convolutions, their extremities being covered by the cineritious matter there. The arrangement is best seen by scraping with a knife along the base of the brain, especially when the latter has been hardened in spirits of wine, and it is constituted by what are called, by MM. Gall and Spurzheim, the diverging fibres of the brain.

The point is not, indeed, entirely settled that the diverging filaments end in the convolutions, or do not rather afterwards inflect or double on themselves, and pass inwards again to the middle line of the brain, forming, by their convergence, the corpus callosum. At all events, the fact is quite demonstrable, that as the under and lateral portions of the hemispheres consist in diverging filaments, arising in and from the crus cerebri, so the upper portion and the corpus callosum consist in filaments which arise in the adjoining convolutions, and collect towards the middle line of the corpus callosum, where they adhere to the congeneric filaments of the other side.

The arrangement, in the most simple conception and illustration of it, would be exemplified by folding a strip of cloth double on itself, so as to convert it into a loop; the under part of the loop would then represent the diverging fibres of the cerebrum and the upper part the converging fibres, or corpus callosum; it being at the same time borne in mind that the continuation of the two orders of fibres into one another in the brain is not so fully ascertained as would be represented by this model.

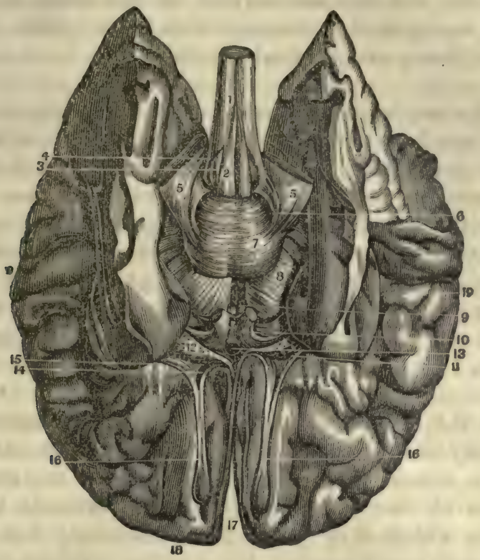
Between these two orders of fibres there is a horizontal cleft or interval. This interval is the lateral ventricle of the hemisphere, which may be got into under the posterior margin of the corpus callosum, from its being open there, or rather only closed by an adhesion of the membranes, which is easily lacerated.

The preceding is intended as a mere outline or base of the descriptive anatomy of the cerebrum. The following, therefore, may be considered as the detailed account.

The Crura Cerebri are rounded below; are about eight lines long, and increased in their transverse diameter as they advance; their ver-

tical diameter is about ten lines. They mutually diverge, beginning from their roots, and are separated by a deep fissure, considered as a repetition of that on the front of the medulla oblongata. Above this

Fig. 273.



A view of the Base of the Cerebrum after the removal of the projecting surface, its middle and posterior lobes of the left hemisphere, as well as of the cerebellum.—1. Superficial intercrossing of the anterior cords of the spinal marrow. 2. Corpus pyramidale. 3. Eminentia olivaris. 4. Corpus restiforme. 5. External surface of the crura cerebelli. 6. Oblique bands extending from the corpora restiformia alongside of the pons Varolii, sometimes seen. 7. The pons Varolii. 8. The crus cerebri. 9. The eminentiæ mammillares. 10. The chiasm of the optic nerves. 11, 12. A perforated space near the roots of the optic nerves, and diverging from these nerves near their chiasm. 13. The position of anterior commissure as shown by the rupture of the cineritious matter. 14. The internal root of the olfactory nerve. 15. Its external root coming from the posterior margin of the anterior lobe of the cerebrum. 16. The bulb of the olfactory nerve. 17. The longitudinal fissure of the cerebrum. 18. The anterior lobe, left side of the cerebrum. 19. The middle lobe of the cerebrum.

fissure is the third ventricle of the brain, which itself is a renewal of the middle fissure on the posterior face of the medulla oblongata. The surface of the crura is marked by superficial furrows, running longitudinally; and about two lines before the tuber annulare, by a transverse fasciculus of medullary matter or white neurine, very slightly elevated: the optic nerves also cross them obliquely at their fore part.

In regard to texture, the crus cerebri presents, on its under surface, a medullary layer of two lines in thickness; to this succeeds a parcel of cineritious matter called the locus niger, which, on being removed, is followed by a mixture of both cineritious and white matter, more abundant than either of the preceding.

The Tuber Cinereum, or Pons Tarini, is a portion of the under surface of the crura cerebri, at the floor of the third ventricle. It is continuous in front with the anterior margin of the corpus callosum by means of a layer of gray matter called the *lamina cinerea;* forms the floor of the third ventricle; and is composed, as its name implies, of

cineritious neurine. It may represent the middle or central commissure of the medulla spinalis.[1]

The Eminentiæ Mammillares, or Corpora Albicantia, are two small bodies, one on each side, about the size of a French pea. They are situated near the anterior extremities of the crura cerebri, on their internal faces, and almost in contact with each other. Their texture is medullary without, and cortical within.

The Infundibulum is placed immediately before the eminentiæ mammillares. It is a flattened conoidal body, half an inch long, with its base upwards, and its apex going downwards and forwards. It is formed of cineritious matter. Most generally its base is hollow, and opens into the third ventricle, but its point is closed. J. F. Meckel, however, asserts that a communication exists entirely through it, from the pituitary gland to the third ventricle, and that he has frequently proved this by passing air or liquids from the gland, though the experiment does not succeed when he attempts the injection from the third ventricle.

In front of the infundibulum the optic nerves unite, after having crossed obliquely the crura cerebri from without inwards and forwards. In this passage, where they reach the middle of the crura, and at the internal border of the same, they come in contact with the tuber cinereum, from which they get a few filaments; but of this, more hereafter.

The Pituitary Gland (*glandula pituitaria*), or Hypophysis, is situated in the Sella Turcica, and is covered so completely by the dura mater, that only a small aperture is left for the point of the infundibulum to pass through and to adhere to it. It is an ovoidal body, the greatest diameter of which is transverse, and amounts to six lines. It is partially divided, so as to give the appearance of two lobes, of which the anterior is much the larger. It is hard and cineritious, with a small quantity of medullary matter within. In each side of it there is a depression from which leads a small canal towards the place where the infundibulum joins it; the two canals are in the latter place united into one. In some very rare cases, gritty matter has been found in it, as there is in the pineal gland. It is also surrounded by pia mater.

The Thalami Optici, called, by Gall, the Posterior Ganglions of the brain (*ganglia postica*), are amongst the most conspicuous parts of the internal structure of the cerebrum, and are two in number, one for either side. They are situated on the superior face of the crura cerebri,

[1] The posterior region of this is called, by some anatomists, the substantia perforata posterior or basis ventriculi: the tuber cinereum is to them the more central part between the eminentia mammillares and the chiasm of the optic nerves; and laterally before the chiasm is a space called the substantia perforata anterior, bounded in front by the roots of the olfactory nerve, it being cribriform, to give passage to the vessels of the corpus striatum.

are about an inch and a half long from behind forwards, and about eight or ten lines broad and deep.

The thalami are convex above and internally. At the junction of these two surfaces is observed a medullary line, described under the name of peduncle of the pineal gland. Their posterior extremity is likewise convex, and is divided into three rounded prominences: one is above the other two, and is the *tuberculum posterius;* the second is below and within (*corpus geniculatum internum*); and the third is below and external (*corpus geniculatum externum*). There is a fourth tubercle (*tuberculum anterius*), which is situated in front on the upper convex surface of the thalamus; it is produced by the fan-like termination of a large medullary fasciculus which comes from the eminentia mammillaris.

The thalami are somewhat flattened on the middle of their convex internal surface, and adhere there to each other by a layer of cineritious substance, called Commissura Mollis. When the brain is very slightly advanced in putrefaction, or has been made soft by dropsy, this junction scarcely seems to exist at all.

The thalami are medullary on the surface presented to the ventricles of the brain, but within they are a mixture of cineritious with medullary matter. The fibres of the medullary are very intimately blended with the crura cerebri, and radiate from within towards the circumference of the brain: some of them are placed in layers, and are connected with the tubercula quadrigemina.

The Tubercula Quadrigemina (or the *nates et testes*) are situated on the superior face of the crura cerebri, and just behind the thalami nervorum opticorum. They are also called *Optic Ganglia* or *Lobes*, from their close connection with the origin of the optic nerve, and with the function of vision. A very complete view of them is obtained by removing the posterior lobes of the cerebrum, and by paring off the vermis superior cerebelli. Though the name implies four distinct prominences, yet they are formed from a common mass of nine or ten lines square, on the posterior surface of which these prominences arise. They are in pairs, and are separated from one another by a crucial depression. The largest, or upper pair, is the Nates, the lower pair the Testes. The external surface of these bodies is medullary, and within they are cineritious. From the Nates there proceeds a considerable medullary fasciculus, which joins the Corpus Geniculatum Internum; there proceeds also from it a second fasciculus, which either joins the optic nerve itself, or the contiguous part of the thalamus. The Testes receive, at their lower end, the valve of the brain, or the superior peduncle of the cerebellum; and there also proceeds from the testis a large fasciculus of medullary matter, which joins the Corpus Geniculatum Externum of the optic thalamus.

The Corpora Striata, or the Ganglia Cerebri Antica, also two in number, one for each side or hemisphere of the brain, are situated before the thalami optici, at the bottom of the lateral ventricles. They are about two and a half inches long, convex on their upper surface, and eight lines broad at their front part, but taper very gradually to

a point behind. They are about four lines apart in front, and are separated there by the septum lucidum, but their posterior extremities diverge from each other, so as to admit the thalami optici between them.

The surface of the corpus striatum is cineritious, but within it consists of cineritious and of medullary matter, placed in layers which alternate with each other. These layers are arranged in a crescentic manner, so as to present the convexity upwards and the concavity downwards. The medullary substance is a continuation of that of the crus cerebri and of the optic thalamus. It enters at the posterior inferior part of the corpus striatum, and immediately divides into three layers, placed one above the other, and of which the two inferior are more narrow and short than the superior. The upper layer, in its progress forwards, is interrupted by a body of cineritious substance, which occasions it to divide into a multitude of distinct radiated fibres. The same circumstance attends the other layers, but in a more limited degree. The medullary matter of the corpus striatum may then be traced, in all directions, into the hemisphere of the brain. The cineritious substance of the corpus striatum is abundant, and is divided by some anatomists into two kinds, one of a light gray, and another of a darker color. The first forms the middle and inferior part of the corpus striatum; the second is in greater quantity, and is found principally above and between the two upper layers. Such is the general plan of the structure of the corpus striatum; but it should also be understood that a close intertexture exists between its medullary and cineritious matter.

The most satisfactory way of exposing the structure of the corpus striatum is to scrape off its under surface, in tracing its medullary matter from the crus of the cerebrum, and through the optic thalamus. It will then be seen that the medullary substance of the crus reaches the posterior inferior part of the corpus striatum, and is immediately invested in the greater part of its circumference with cineritious matter; it then begins to expand after the manner of a fan into filaments. These filaments or fasciculi penetrate the cineritious matter in various directions, besides those just detailed. A particular exposition of them is given by Gall and Spurzheim, in their anatomy of the brain.

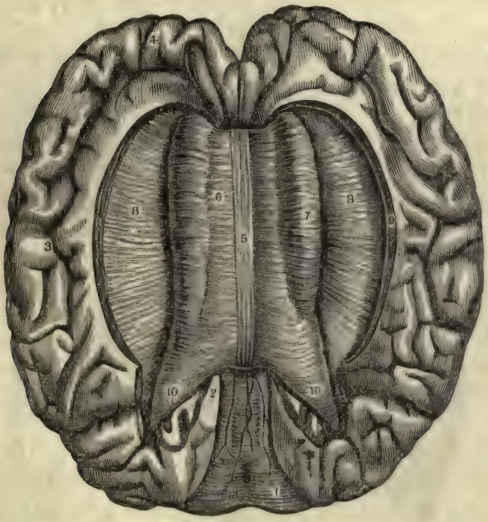
The Tænia Striata or Semicircularis is placed in the angle formed between the internal margin of the Corpus Striatum, and the external one of the Thalamus Opticus, where these two bodies are in contact and continuous with one another. It is a small medullary band, not a line in breadth, commencing near the anterior crus of the fornix, with which it is connected by filaments. Observing the curved course of the gutter in which it is placed, it goes to the posterior end of the corpus striatum, and even beyond it in most cases, by uniting itself to the top of the Cornu Ammonis.

The Corpus Callosum.—When the fissure between the hemispheres of the cerebrum is widely separated, or when the superior part of the hemisphere is cut away on a level with the bottom of the fissure, the Corpus Callosum, a medullary layer, as stated, is brought fully into

view. This body unites the medullary mass of the two hemispheres, and is a large commissure. It occupies about two-fifths of the long diameter of the brain, being nearer to its anterior than to its posterior end, and is about eight lines broad; increasing, however, somewhat in breadth posteriorly. The lateral half of it, on either side, is concealed by the hemisphere overlapping it, but is prevented from adhering by a horizontal fissure, which extends from one end to the other. It has an arched form, being convex above and concave below. Its thickness is uniformly about three lines, with the exception of its anterior and its posterior margin, which are more. Just above the horizontal fissure there exists a convolution (*gyrus fornicatus*) in which is a longitudinal layer of white neurine running from one end to the other of the flat surface of the hemisphere, described by Mr. Solly.[1]

The middle line of its upper surface is marked out from one end to the other by a very slight depression, the Raphé; on each side of which there is a very small linear elevation (*stria longitudinalis*) of the same extent, but slightly curved inwards towards its fellow. From these longitudinal lines there proceed outwardly transverse ones, having a filamentous appearance. Other longitudinal lines also exist on

Fig. 274.



A view of the extent and shape of the Corpus Callosum as seen from above, the flat side of the hemispheres being opened like a bivalve shell spread out.—1. The cerebellum. 2, 3, 4. The convolutions on the inner flat face of the hemisphere. 5. The median tract, or raphé of the corpus callosum. 6. Its transverse fibres. 7. The fibres curved upon its outside. 8. The converging fibres of the hemispheres. 9. The edge of the hemisphere which overhangs the side of the corpus callosum. 10, 10. The posterior extremities of the corpus callosum.

the surface of the corpus callosum, but they are not seen with equal facility. At the anterior and posterior ends of the corpus callosum, the fibres are somewhat curved, and radiate towards the periphery of

[1] Anatomy of Brain, 1836.

he brain. The anterior extremity of the corpus callosum is rounded off, and bent downwards towards the basis of the brain, in such a manner as to present backwards its concavity; which thus embraces the fore part of the corpora striata, and closes the lateral ventricles at this point. The posterior end of the corpus callosum is rounded also, and continuous with the fornix and with the cornu ammonis.

By examining the Corpus Callosum from below, or by looking at its relative situation and shape on a hemisphere which is accurately separated from its fellow in the middle line, it will be seen that its lower surface is very concave, being highly arched from before backwards; that it forms the roof of the lateral ventricles; and that this surface of it is about two inches in its transverse diameter, and, therefore, more than twice as broad as the upper surface.

The corpus callosum is formed almost wholly of filaments of white neurine.

The Fornix or vault (*trigone cérébral* of the French) is placed immediately below the corpus callosum. It is a triangular body of medullary neurine or matter, the base of which is behind and the apex in front. It is about an inch and a half long in its body, and one inch

Fig. 275.

A section of the Cerebral Hemispheres, showing both lateral ventricles, after the fornix has been divided and turned back, to expose the velum interpositum. *c*. The anterior portion of corpus callosum, cut across. *e*. The lyra, or under surface of fornix. *f*. Anterior pillars of fornix cut across. N. B. These are represented of too great size. *g*. Anterior, *h* posterior, cornu of lateral ventricle. *k*, *k*. Corpora striata. *q*. Pes hippocampi. *r*, *r*. Thalami optici. *z*, *z*. Tænia hippocampi. *T*, *T*. Choroid plexus. *v*. Velum interpositum. *x*, *x*. Posterior pillars of fornix. *y*. Tænia striata.

wide at its base. It is the latter part, which, lying immediately beneath the posterior end of the corpus callosum, is continuous with it,

and causes the fornix to be considered as a part of the same structure with the corpus callosum. These two bodies, which may be compared to a sheet of medullary matter doubled on itself, have their surfaces in contact for a short distance behind; the fornix afterwards, by advancing and keeping itself in close contact with the thalami nervorum opticorum, which are just below it, diverges more and more from the under surface of the corpus callosum. It conceals the upper surface of the thalami except their external margins, and, having reached their anterior extremities, its apex descends towards the basis of the brain.

The body of the fornix is about a line thick, but at its anterior extremity, it becomes somewhat cylindrical, and is divided into two columns or legs, called Crura Fornicis Anteriora. Each of these crura, in descending, adheres to the anterior extremity of the thalamus of that side, and, getting finally below it into the floor of the third ventricle, it, after a course slightly curved, joins the cortical substance of the Eminentia Mammillaris. Santorini, aware of this junction, considered the eminentiæ as a part of the fornix, and, therefore, called them Bulbi Fornicis.

The fornix has other attachments of a more complex description, which the anatomist should attend to, as they serve to indicate the modes of intercourse between the several parts of the cerebrum. Its fibres having reached, and probably formed, the eminentia mammillaris, one fasciculus of them ascends from thence along the internal face of the optic thalamus, invested by the cineritious matter of the latter, and spreads itself above like a fan, and forms the tuberculum anterius; a second fasciculus from the same point, having divided into two, after going a short distance, sends one division backwards along the upper internal face of the optic thalamus, to join the peduncle of the pineal gland, and the other division, which is more anterior, runs to join the tænia striata; the third fasciculus from the eminentia mammillaris, being covered by the optic nerve, goes outwards and backwards to terminate in the thalamus.

The posterior margin, or the base of the fornix, besides running into the corpus callosum, has the angle on each side elongated so as to rest upon and to join the upper end of the cornu ammonis. The angle, being continued, then follows the winding course of the latter, adhering to its posterior margin, but hanging loosely over the anterior. This loose edge or continuation of the external margin of the fornix is the Tænia Hippocampi, or Corpus Fimbriatum of the Lateral Ventricle. The elongations of the posterior angles are called Crura Posteriora Fornicis. In the brains of individuals who have suffered from general dropsy, one frequently finds the fornix narrower than usual, and in its middle a fissure which separates almost completely its two halves.

As the fornix is fitted to the upper surface of the optic thalami, it is of course concave below and convex above, or resembles a triangular arch resting upon its three points or angles. Owing to some misunderstanding of the original Greek word ψαλιδες, which, according to the interpretation of Sabatier, means a vault, and thereby expresses the whole body, anatomists, with the exception of him, have generally supposed the striated under surface of the fornix to be meant by it, and

have therefore called the surface Lyra, in which mistake one has followed another.

The Septum Lucidum is a partition placed vertically in the middle line of the brain, and extends from the corpus callosum above to the fornix below. It is of a triangular shape, but irregularly so, being much broader before than it is behind, and having its edges so incurvated as to fit the bodies against which it is applied.

The septum lucidum is formed by two laminæ placed side to side, but not adhering to each other, and leaving, therefore, an interval between them, called the Ventriculus Septi, or the fifth ventricle. Each of these laminæ consists of two layers: the internal is medullary substance, continuous with that of the corpus callosum and of the fornix; and the external is a layer of cineritious substance. The cavity is about an inch and a half long by a line wide, and is narrower in the middle than at either extremity. It is lined by a delicate serous membrane, which becomes manifest when the halitus that naturally covers its surface is accumulated into a body of water. It is generally supposed to be insulated or completely shut up, yet occasionally it has been found elongated in front, towards the space between the anterior commissure and the crura fornicis, and to communicate there with the third ventricle.[1]

The Pineal Gland (*glandula pinealis, conarium*) is placed beneath the posterior margin of the fornix, upon the superior of the tubercula quadrigemina, or the nates. It is an oblong conoidal body, the longest diameter of which is transverse, and amounts to three or four lines, while the short diameter is near three lines. These diameters are, however, sometimes reversed. The substance of the pineal gland is cineritious and of a reddish color. At its inferior part there is a small cavity, sometimes lined with medullary matter, and the orifice of which looks towards the third ventricle.

This body is connected to the adjacent parts by several cords. From its bottom there proceeds, on each side, the long medullary filament, called its Peduncle, which runs along the upper internal face of the thalamus opticus, and, as observed, joins, or is continuous with, one of the filamentous processes from the Eminentia Mammillaris as connected with the anterior crus of the fornix. From its base there proceeds a transverse lamina of medullary matter, called the Posterior Commissure of the brain, which first advances forwards, and then recedes, so as to be in some measure bent or doubled on itself. This lamina, at either end, is united to the upper posterior part of the corresponding optic thalamus, and by its lower margin runs into the superior edge of the tubercula quadrigemina.

Frequently, within the pineal gland, and sometimes on its surface, there is an accumulation of calcareous matter, the Acervulus Cerebri, that appears about the sixth year of life, and continues forever afterwards. It is variable both in quantity and in its mode of concretion, for sometimes there are only a few atoms of grit, scarcely distinguish-

[1] J. F. Meckel.

able by the feel; while, on other occasions, it is collected into a body of irregular shape, and more than a line in diameter. The pieces of which the acervulus consists are sometimes united by cellular substance and enclosed in a sac. The chemical analysis presents phosphate of lime in large proportion, carbonate of lime, and animal matter.

There are some analogies of texture between the exterior of the Pineal Gland and the Glandulæ Pacchioni, as the latter appear on the different processes of pia mater. This analogy is closer than that of Pacchioni's glands in the longitudinal sinus, with those on the pia mater.

A reflection of pia mater, called Velum Interpositum, separates the pineal gland from the fornix, and the fornix from the thalami nervorum opticorum.

Of the Ventricles of the Brain.

These cavities are four in number: two, called lateral, are placed each one in its respective hemisphere of the cerebrum, a third is between the two thalami, and the fourth under the cerebellum. They have all been alluded to, but only incidentally.

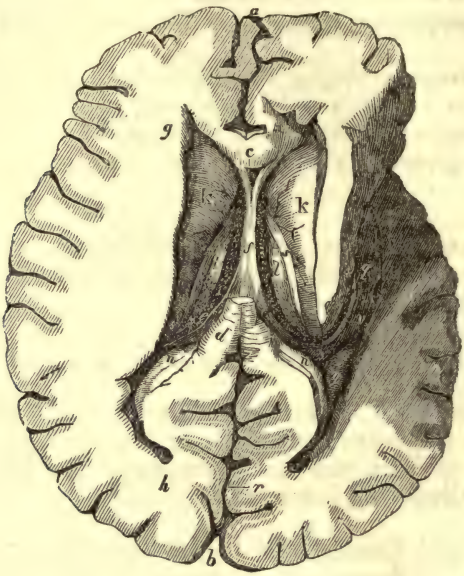
The two Lateral Ventricles (*ventriculi laterales*, *tricornes*) are horizontal cavities, or fissures, of an extremely irregular shape, in the very centre of the hemispheres, being the interval between the diverging and converging filaments of the cerebrum. They are separated from each other only by the septum lucidum, are covered over by the corpus callosum, and have the fornix, thalami optici, and corpora striata for a floor. Each one consists in a body or principal cavity, and three processes, called cornua. The body has been sufficiently described in speaking of the parts which constitute its parietes; but the processes are yet to be considered.

The Cornua, from their position, are named Anterior, Posterior, and Lateral or Inferior. The Anterior is a very small space between the anterior extremity of the corpus striatum and the opposite surface of the hemisphere, and has nothing in it particularly deserving of notice. The Posterior Cornu extends from the base of the fornix to the distance of an inch or more in the substance of the posterior lobe of the cerebrum. Its cavity is conoidal, somewhat curved, with its convexity outwards, and is six or seven lines in diameter at its base. Its internal side is furnished with an oblong eminence called Hippocampus Minor, or Ergot, from its resemblance to a cock's spur, but its size and form are somewhat variable. When this eminence is cut through transversely, it is easy to see that it is formed by a convolution of the posterior lobe projecting into the posterior cornu. The convolution is covered by medullary matter on the side of the ventricle, and of course by cineritious on the side of the periphery of the brain, and is the bottom of an anfractuosity.

The Inferior, Middle, or Lateral Cornu of the Lateral Ventricle is situated in the middle lobe of the cerebrum. It commences at the pos-

terior angle of the fornix, and winds downwards and forwards in a semicircle towards the fissure of Sylvius, presenting its convexity out-

Fig. 276.



Section of Cerebrum, displaying the lateral ventricles. On the right side the descending cornu is laid open.—*a*, *b*. Parts of great longitudinal fissure. *c*. Section of front of corpus callosum. *d*. Part of posterior end of the same. *f*. The body of the fornix. *e*. The left choroid plexus. *g*. Anterior cornu, *h*, posterior, and *q*, descending cornu of the lateral ventricle. *k*, *k*. Corpora striata. *l*, *l*. Optic thalami. *n*, *n*. Right and left hippocampus minor. *o*. Posterior crus of fornix, becoming continued as the tænia hippocampi. *v*, *q*. Cornu ammonis, or pes hippocampi. *r*, *s*, *s*. Right and left tænia striata. *v*. Corpus fimbriatum. *y*. Posterior end of hippocampus major.

wards, and its concavity within. Its floor is furnished in its whole length with an elevated ridge, the surface of which is semi-cylindrical. This ridge is the Cornu Ammonis, or Hippocampus Major, and increases somewhat, both in breadth and elevation, as it winds down the process of the ventricle. Its lower or anterior extremity is terminated by two or three small tubercles, and is the Pes Hippocampi. Occasionally the Hippocampus Major is marked off by a middle longitudinal fissure into two elevations, of which the external is the smaller. On its concave side there is the thin edge of medullary matter, continuous with the external margin of the fornix. The extremity of a knife handle may be insinuated for a short distance between this edge and the Hippocampus; it ceases about half way down the latter, and in the natural state of the parts is concealed by the plexus choroides. This edge is, as mentioned in the account of the fornix, the Tænia Hippocampi or Corpus Fimbriatum of the lateral ventricle. Beneath the latter and partially covered by it, there is another body, which presents itself in the form of a small cord of cineritious matter, not quite so long as the Tænia, and is called Fascia Dentata, from being divided into several sections by transverse fissures, which give it a tooth-like appearance.

A transverse incision of the Hippocampus Major shows that it is a body of cineritious matter, covered on its surface by a thin layer of medullary substance.

When the fornix is separated from its anterior crura and turned over backwards, the process of pia mater, called Velum Interpositum, is found between it and the optic thalami. This process is of a triangular shape, resembling the fornix, and is about the same size; it is insinuated into its place from the surface of the brain, under the posterior margin of the corpus callosum. Its lateral margins, which project beyond the corresponding ones of the fornix, are formed by a congeries of convoluted vessels, constituting the Plexus Choroides.

The Plexus Choroides may be traced from the Pes Hippocampi along the corpus fimbriatum to its position on the margin of the velum interpositum, and insinuates itself from the bottom of the cerebrum between the pons Varolii and the convolution forming the Hippocampus Major; but when it reaches the anterior end of the fornix, its convoluted character ceases, and it terminates, on each side, in a single vein (*vena galeni*), which runs from before backwards, in a straight line, near the middle of the velum interpositum. The vein, finally, unites with its fellow to form a single trunk, the Vena Azygos Cerebri, which runs into the fourth sinus of the dura mater.

This Velum Interpositum, called also Tela Choroidea, adheres very strongly to the fornix by means of small vessels: it may be raised with less difficulty from the thalami, though it serves to keep the third ventricle closed above, with the exception of the part just behind the crura of the fornix, where the third and the lateral ventricle communicate by the foramen of Monro. The pineal gland is entangled in its posterior part, being placed below it, and is generally torn from its peduncles when the tela is raised up. It is at this point that the tunica arachnoidea may be traced into the cavity of the lateral ventricles, according to Bichat.[1]

The Plexus Choroides, which is stated to bound the Velum Interpositum on each side, and to descend along the Hippocampus Major to the fissure of Sylvius, or rather to ascend from this point, and to terminate in the vein on the side of the middle line of the Velum, is narrow at its termination, but increases continually in breadth as it is traced towards its commencement. The middle part, however, where it makes its turn, is an exception to this rule, for there it is larger in every way than elsewhere: its vessels being more capacious and more tortuous. Precisely at this point one or more vesicles are very frequently found, considered by some as hydatids of the brain; in some cases they are filled with calcareous matter instead of with water. The Glandulæ Pacchioni, as stated, also prevail at this margin.

On the under surface of the Velum Interpositum, adhering to it, there is on each side a small venous plexus which goes from before backwards,

[1] Some doubts, I have mentioned before, may be reasonably raised on this point of anatomy, as the evidence is seldom or never satisfactory to the full extent, and as such an arrangement would be contradictory to that of the tunica arachnoidea on the surface of the brain, which never dips into fissures.

and terminates in the vena galeni, near its junction with its fellow. It receives the blood of the third ventricle.

There is also the same sort of plexus in the fourth cerebral ventricle.

Upon the removal of the Velum Interpositum, or its elevation, the whole upper surface of the thalami optici is exposed. The third ventricle is also brought into view, being placed immediately between the thalami optici.

The Third Ventricle (*ventriculus tertius*) is a narrow, oblong cavity, bounded below by the pons Tarini, crura cerebri, and the eminentiæ mammillares, and above by the velum interpositum and the fornix. It is an extension of the posterior middle fissure of the medulla oblongata conducted along the middle of the pons Varolii. The anterior crura of the fornix are at its fore part, and just before them is the Anterior Commissure (*commissura anterior*). This body is a transverse fasciculus of medullary matter, which passes from one hemisphere to the other through the anterior margins of the thalami optici. Its middle part is rounded and free, but its extremity penetrates on each side into the substance

Fig. 277.

Section of the Cerebrum, displaying the surfaces of the corpora striata, and optic thalami, the cavity of the third ventricle, and the upper surface of the cerebellum.—*a*, *e*. Corpora quadrigemina—*a* being nates, *e* testis. *b*. Soft commissure. *c*. Corpus callosum. *f*. Anterior pillars of fornix. *g*. Anterior cornu of lateral ventricle. *k*, *k*. Corpora striata. *l*. *l*. Optic thalami. *Anterior tubercle of the left thalamus. *z* to *s*. Third ventricle. In front of *z*, anterior commissure. *s*. Posterior commissure. *p*. Pineal gland with its peduncles. *n*, *n*. Valve of Vieussens. *m*, *m*. Hemispheres of the cerebellum. *h*. Superior vermiform process. *i*. Notch behind the cerebellum. *u*, *u*, *v*, *v*. Laminar condition of cerebellum.

of the anterior inferior portion of the corpus striatum, and spreading out gradually describes a curve with its convexity forwards, which ter-

minates near the Pes Hippocampi of the inferior cornu of the lateral ventricle. This fasciculus, in penetrating the corpus striatum, does not mix with its substance, but, in the early part of its course, goes in a canal formed in the latter. In order to see this arrangement, a part of the corpus striatum must be removed. The anterior commissure resembles a nerve in its structure, as it is surrounded by a very delicate sheath, and is divided into fasciculi of fibres. It will now be understood that three commissures are found in the third ventricle, the Anterior Commissure; the Posterior, which is just in front of the Pinea Gland;[1] and the Soft Commissure, being a cineritious adhesion of the Thalami at their middle.[2]

Just behind and below the anterior commissure, the base of the infundibulum opens into the third ventricle; this place is the Iter ad Infundibulum. At the posterior extremity of the third ventricle, just below the posterior commissure, which has been described as a process of the pineal gland, the communication exists with the fourth ventricle. This passage is the Aqueduct of Sylvius, or the Iter e tertio ad quartum ventriculum, and leads obliquely downwards and backwards under the valve of the brain.

The third ventricle communicates freely with the lateral ventricle through the aperture called the Foramen of Monro, which is situated just at the place where the plexus choroides terminates; that is, under the anterior crus of the fornix. Doubts have been suggested in regard to the natural existence of this communication; it only requires a moderate degree of accurate observation to dispel them: they have arisen, probably, from the aperture being shut up by the occasional adhesion of the plexus choroides to the contiguous surface of the brain.

The Fourth Ventricle (*ventriculus quartus, cerebelli*) has been, in a great degree, described in the account of the neighbouring parts; it will, therefore, be very readily understood on the present occasion. It is an irregular triangular cavity, the base of which is downwards. It is bounded in front by the tuber annulare and the medulla oblongata, behind by the fundamental portion of the cerebellum, and above by the valve of the brain and the tubercula quadrigemina; it is under the latter that the communication between it and the third ventricle is found. Its lateral parietes are formed by the medullary prolongations from the cerebellum to the tubercula quadrigemina. This cavity, as stated, is open below, when that portion of pia mater and of the arachnoidea is removed which passes from the cerebellum to the medulla oblongata.

From what has now been said of the connection of the pia mater with the ventricles, it will be understood that, as their surfaces are covered by pia mater, and the removal of it exposes their cavities, they are in fact continuations of the external surface of the brain. The ventricles are generally found upon death to contain two or three teaspoonfuls of light-colored serum, called by Magendie the Encephalo-spinal fluid. In Williams, examined immediately after his execution, August 9, 1839, the encephalo-spinal fluid, amounting to from two to three drachms,

[1] See Pineal Gland.

[2] See Thalami.

came out clear and abundant from the fourth ventricle, on cutting through the tunica arachnoidea which bounds it below.

SECT. VI.—OF THE NERVES OF THE ENCEPHALON.

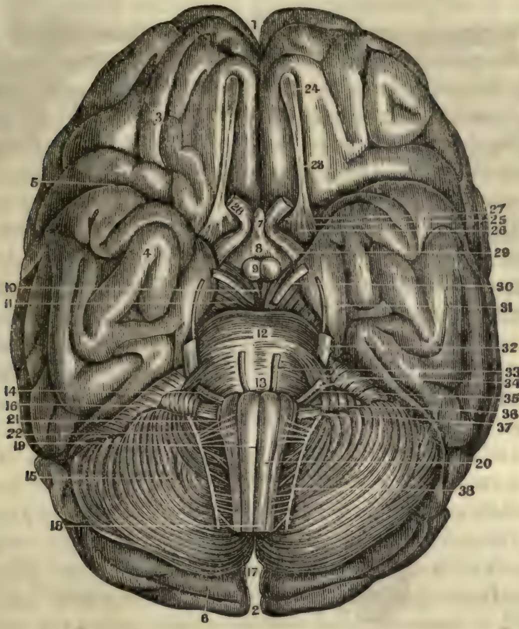
These nerves are designated numerically, from before backwards, and also by some peculiarity of distribution and of function. This numerical arrangement is the most sanctioned by age and general admission; it is not, however, so unexceptionable as to avoid all objections to it; improvements have, therefore, been suggested from various quarters, founded on particular anatomical or physiological considerations; but the improvements themselves are exposed to objections as strong as the numerical arrangement. For example, the innovators are not agreed in regard to the proper number of nerves, nor on those which should be considered distinct from each other. Some do not consider the olfactory as a nerve, but only a ganglion; some consider the glosso-pharyngeal and par vagum as but one nerve, while others speak of them as two. Some make but one nerve of the third and sixth, owing to their common distribution to the muscles of the eye. It is evidently expedient, under these circumstances, to escape a contrariety of opinions, by adhering to the most received classification, at least till the ground of change be better explored and more universally acknowledged. If there be anything of incalculable importance to the comfort of students and scientific men generally, it is uniformity of language, or rather conformity to a received standard of nomenclature and of description. The only justifiable departure from this rule is where something new has been actually discovered; a necessity, of course, then exists for giving a new name, as it would not do to take the appropriated one of anything else.

The Olfactory Nerve (First Pair, *nervus olfactorius*, *par primum*) is situated on the under surface of the anterior lobes of the brain, near the fissure that separates the hemispheres. It goes forwards from its root, and also converges gradually towards its fellow, so as to reach the cribriform plate of the ethmoid bone, through the perforations of which it passes out. In its course, it is lodged in a small furrow of the cerebrum, by which pressure upon it is prevented.

This nerve arises by three medullary fasciculi, or roots, from the basis of the brain at the corpus striatum, in the fissure of Sylvius, where the anterior and middle lobes join each other: these roots are from eight to twelve lines on the outer side of the infundibulum. The roots are placed, in regard to each other, diverging; one is within, another in the middle, and the third external. The external root is the longest, and arises from the extreme posterior margin of the anterior lobe by its last convolution; being connected with the middle lobe, and also with the anterior commissure of the brain. It has a curved course from without inwards, the concavity of which is forwards, and the convexity backwards. The internal root is concealed by the chiasm of the optic nerves, and arises from the adjacent surface of the anterior lobe. The middle root comes from the posterior margin of the anterior lobe by the cribriform surface (*subs. perf. anter.*), which is between the other two roots.

These origins, emanating from the cortical substance, unite to form a single prismatic cord, which increases in size as it advances forwards, and consists of medullary and cineritious longitudinal fibres.

Fig. 278.



A view of the Base of the Cerebrum and Cerebellum, together with their Nerves.—1. Anterior extremity of the fissure of the hemispheres of the brain. 2. Posterior extremity of the same fissure. 3. The anterior lobe of the cerebrum. 4. Its middle lobe. 5. The fissure of Sylvius. 6. The posterior lobe of the cerebrum. 7. The point of the infundibulum. 8. Its body. 9. The corpora albicantia. 10. Tuber cinereum. 11. The crus cerebri. 12. The pons Varolii. 13. The top of the medulla oblongata. 14. The crus cerebelli. 15. Laminæ of cerebellum. 16. Anterior part of the cerebellum. 17. Its posterior part and the fissure of its hemispheres. 18. Superior part of the medulla spinalis. 19. Middle fissure of the medulla oblongata. 20. The corpus pyramidale. 21. The corpus restiforme. 22. The hypoglossal, or ninth nerve; its upper root is here seen, which deceptiously in the figure attaches apparently to the trunk of the spinal accessory. The line indicating this root crosses the corpus olivare, and also points to it. 23. The olfactory nerve. 24. Its bulb. 25. Its external root. 26. Its middle root. 27. Its internal root. 28. The optic nerve beyond the chiasm. 29. The optic nerve before the chiasm. 30. The motor oculi, or third pair of nerves. 31. The fourth pair, or pathetic nerves. 32. The fifth pair, or trigeminus nerve. 33. The sixth pair, or motor externus. 34. The facial nerve. 35. The auditory—the two making the seventh pair. 36. Glosso-pharyngeal. 37. Pneumogastric. 38. Spinal accessory.

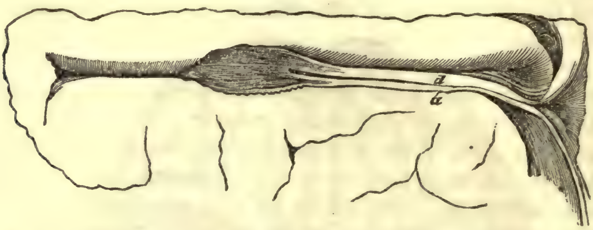
The anterior extremity of the olfactory nerve is swollen out into what is called the bulb[1] (*bulbus*), and sends from its under surface filaments, which, surrounding themselves with a tunic from the dura mater, penetrate into the nose, and spread themselves on the Schneiderian membrane. In its whole length it is exceedingly soft and pulpy, till it gets out of the cranium.

Dr. Leidy is inclined to reject the term roots, and to view this arrangement as a commissural one or pedicle, uniting the olfactory bulb or ganglion to the brain. The first root he calls the external commissural band; the second the internal commissural band; a fissure is between them, held together by pia mater; when spread out, the two make

[1] Anatomists consider this as a Ganglion, from its extreme development in the sheep, bullock, horse, &c., and, therefore, call it the Olfactory Ganglion.

a single white layer. Above is the middle root or superior commissural band, formed of ganglionic substance from the locus perforatus to the

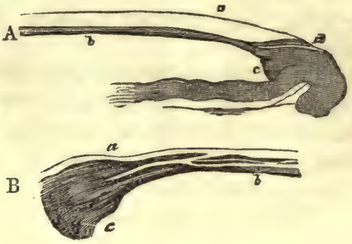
Fig. 279.



Represents an inferior view of the Right Olfactory Ganglion and Commissure.—*a*. External commissural band. *d*. Internal commissural band.—J. Leidy.

olfactory bulb. At the junction of the bands with the latter is a small cavity lined with epithelium.[1]

Fig. 280.



A represents the appearance of the internal face of the Olfactory Pedicle of the left side.—*a*. Internal commissural band. *b*. Superior or middle gray band. *c*. Protuberant base of the olfactory pedicle. *d*. Escape of a white fibre from the gray substance going to join the white band.

B represents the appearance of the external surface of the Olfactory Pedicle of the left side. *a*. External commissural band joined by white fibres escaping from the superior gray band (*b*). *c*. Continuation of the locus perforatus around the protuberant base of the olfactory pedicle.—From nature, by J. Leidy.

The Optic Nerve (Second Pair, *nervus opticus, par secundum*) is about the same size with the trigeminus. It arises by a broad flattened root, one portion of which comes from the posterior end of the thalamus opticus, and another from the corpora quadrigemina, through the means of a medullary band that passes from the latter towards the thalamus of the same side. From this point the optic nerve winds forwards as the *optic tract* under the crus cerebri, adhering to it and forming a connection with the tuber cinereum, and then inclining inwards towards its fellow. Its adhesion to the crus is considered by many anatomists as another of its origins.

The optic nerve, having reached the under anterior part of the third ventricle, adheres so closely to its fellow that the two seem blended together, in such a way that there is no line of separation between them. This junction receives, above from the third ventricle, some medullary filaments, which Meckel feels authorized to consider as another origin. The junction presents a resemblance to the letter X, and is called the

[1] Sharpey and Quain, Phila. ed. vol. ii. p. 244.

chiasm or crossing of the optic nerves. Anatomists have labored to settle the question of the mode of junction; some believing that there was only a lateral union, others that the nerve of one side crossed over to the other side, and others, again, that the decussation occurred only with some of the fibres, but not all. Observations, in comparative anatomy, on blindness, and indeed on every conceived mode of elucidation, have been resorted to.

All the circumstances of this junction are perhaps not yet ascertained, but it is agreed that the more interior or central fibres of the optic tract cross to the other side, while the external lateral fibres go to the corresponding eye. It is further asserted that the posterior border of the chiasm is formed of fibres which do not go at all to the eye, but resemble the letter V, rounded at its angle, with each leg running into its respective side of the Corpora Quadrigemina (*ganglion opticum*). The anterior border of the chiasm is of the same form, with its legs running each into its respective retina, and it does not communicate with the corpora quadrigemina. The anterior and posterior borders are therefore much like commissures.

My own examinations have resulted in exhibiting decussating fibres behind, a junction in front, like the two sides of the letter U, and a common mass in the centre.

The arrangement in the lower orders of animals is conformable to their sphere or condition of vision. In the mole, there is only the posterior fasciculus or commissure; a mere rudiment, therefore, of the optic nerve. In osseous fishes, where each eye, from its lateral position, has an exclusive sphere of vision, the whole of the optic nerve crosses to the other side. Mr. Mayo, of London, who has made valuable observations on this subject, says that the outer fibres of the optic nerve supply the outer part of the retina of the same side, and that the central decussating fibres go to the inner part of the retina of the other side, which corresponds with the points of the two retinæ right and left, upon which images fall laterally. He admits the posterior inflection from one side to the other.

The researches of Flourens, and of Hurtwig, have proved the influence of the corpora quadrigemina on vision, and therefore the commissural state of the optic chiasm. The destruction of the corpora on one side extinguishes vision on the other in experiments on animals. In man, frequent cases have occurred of blindness from disease of the corpora quadrigemina.

The optic nerves, as they approach their chiasm, become more cylindrical, and, continuing so afterwards, penetrate into the orbits through the foramina optica. It is only in front of their junction that they are invested by a neurileme; which, having considerable firmness, penetrates into their interior, and divides them into distinct canals.

The Nervus Motor Oculi (Third Pair, *par tertium*) arises from the internal face of the crus cerebri, about two lines in advance of the anterior margin of the tuber annulare. Its roots come, in great part, from the cineritious matter which is found on the surface of the crus, and makes its locus niger internally. They may be traced for some distance upwards and backwards along the parietes of the third ventricle.

The nerves of the opposite sides are in contact for some distance by the internal faces of their roots, but do not adhere.[1]

The nervus motor oculi proceeds from its origin towards the internal margin of the cavernous sinus, and, penetrating into the orbit through the sphenoidal foramen, it is distributed to most of the muscles of the eyeball.

The Pathetic Nerve (Fourth Pair, *nervus patheticus, par cerebrale quartum*) is the smallest which comes from the encephalon, and is not larger than a sewing thread. It arises by two filaments, or roots, from the upper end of the valve of the brain, just below the testis. This origin is soft, connected by a band with the origin of the corresponding nerve, and easily broken, from the want of a neurileme ; but the latter is soon afterwards furnished.

The nervus patheticus appears on the base of the brain, between the cerebellum and the posterior lobe of the cerebrum, at the external margin of the tuber annulare. It goes for some distance along the margin of the tentorium till it comes near the posterior clinoid process; it then penetrates into a canal of the dura mater, and reaches the orbit of the eye through the sphenoidal foramen, to be distributed on the superior oblique muscle.

The Nervus Trigeminus (Fifth Pair, *par quintum*, also called *trifacial*) is one of the largest among those that proceed from the basis of the brain, and emerges from the side of the pons Varolii, just where it is continuous with the crus cerebelli. It is composed of two principal roots : an anterior, and a posterior,[2] of which the latter is much the larger.

The Posterior root, also called Sensory, is about a line and a half in breadth, and has a passage made for it by the very obvious splitting of the superficial fibres of the pons Varolii. It is composed of thirty or forty fasciculi, which are divisible into a hundred or more fibres. These fasciculi may be traced into the substance of the pons Varolii, but intersected by the transverse fibres of the latter, and are in the direction of the fourth ventricle. When they have come near the latter, they may be traced thence into the medulla oblongata, towards the fissure that exists between the corpus olivare and restiforme. It is at this point that the greater number of the fibres arise ; some from the corpus olivare, and others from the fissure.

The commencement of this root is pulpy and destitute of filaments, and is surrounded by grayish substance; but, when it has advanced into the pons, it is surrounded by a fine membrane, and is very evidently filamentous. There is a successive increase in its size, from its commencement till it is ready to emerge from the pons, when it becomes somewhat contracted, and immediately afterwards increases again considerably in size. It then enters a canal of the dura mater at the fore

[1] Mr. Solly considers this nerve to arise from the interior of the pons Varolii, and to be connected with the valve of Vieussens by some fibres from the latter going into the crus cerebri.

[2] Santorini, Observ. Anat. Venitia, 1724. Sœmmering, de Corp. Hum. Fabrica, tom. iv. Gall and Spurzheim, Anat. du Cerv.

part of the petrous portion of the temporal bone, and just behind the cavernous sinus. In the superior border of this canal there is, most frequently, according to the observations of Dr. Leidy, a small ossification. This canal sets but loosely about it at first, but afterwards adheres to the surface of the nerve.

The Posterior root of the nervus trigeminus, in the upper part of the canal of the dura mater, preserves its fasciculated appearance, and many small filaments are interchanged between the fasciculi, so as to make a complex net-work. But, at the lower part of this canal, it is converted into a ganglion of a semilunar shape, with its concavity upwards, being about six or eight lines in length, and one and a half in breadth. This body, called the Ganglion of Gasser or Casser (*ganglion semilunare, plexus gangliformis*), is compact, and has its fibres very much matted above, but below they assemble into larger and more distinct fasciculi, which are afterwards arranged into three principal trunks, departing from the cranium through different foramina; to wit: through the sphenoidal foramen, the foramen rotundum, and the foramen ovale.

J. F. Meckel asserts that the filaments of the plexus above the ganglion for the most part terminate in a gutter formed in the superior margin of the ganglion, and that there are but very few of them which can be traced into the trunks below. The trunks below, consequently, arise from the circumference of the ganglion.

The Anterior root is formed of two smaller, which proceed out of the tuber annulare at different points from that of the large root, but very near it, and each one has its appropriate fissure for that purpose. One, from its situation, is anterior, and the other posterior. Each may be traced into the posterior cord of the medulla oblongata, but not so far as the posterior root, and is formed by several fasciculi of medullary fibres. The anterior and posterior division, after going separately for six or eight lines, unite to form a single cord.[1] These two constitute what is called the Motory root of the fifth nerve. This cord does not merge itself in the semilunar ganglion, but continues distinct from it,[2] with the exception of sending off to it a few fasciculi; and it sometimes has its own distinct canal and aperture in the dura mater, for passing through it; it afterwards gets from the cranium through the foramen ovale, and is distributed to some of the muscles of mastication, as the temporal and the buccinator. It is called the Motor Root, from its analogy with the anterior root of the spinal nerves.

The general distribution of the fifth pair of nerves, or the trigeminus, is to the orbit, to the face, and to the tongue.

The Nervus Motor Externus Oculi (Sixth Pair, *par sextum*) arises from the base or upper extremity of the corpus pyramidale, under the posterior margin of the tuber annulare or Pons: when the latter is broader than usual, some of the fibres seem to come from it, but the appearance is deceptious, as they only penetrate it. The fibres are assembled into two roots, of which the internal is three or four times as large as the other.

These roots, before they penetrate the dura mater, most commonly

[1] Mr. Solly considers it to arise from the valve of the brain near its root. Mr. Bell and Retzius considered the anterior corpus pyramidale as its origin.

[2] In this respect the fifth pair resembles one of the spinal nerves.

unite into a single trunk, which goes almost directly forwards, and is enveloped in a neurileme. Passing through the cavernous sinus, it gets into the orbit by the sphenoidal foramen, and is spent upon the abductor oculi muscle.

The Seventh Pair of Nerves is composed of the Facial and the Auditory.

The Facial Nerve (*nervus facialis, portio dura septimi, par septimum*) is placed in front of and above the auditory nerve. It arises by two branches, which are perfectly distinct from each other, and differ much in their size. The larger one, which is placed within and above the other, arises from the medulla oblongata at the most superior part of the corpus restiforme, where the latter joins the tuber annulare. The origin of the nerve is sometimes overlapped by the latter, so that some few of its fibres appear to come from the annular protuberance, while they only pass through it, in their course from the medulla oblongata. The second branch, which is much smaller than the other, and is called by some the Pars Media of the Seventh Nerve, arises by three or four filaments, from that portion of the medulla oblongata which is placed between the first branch and the auditory nerve.

The two branches of the facial nerve are kept distinct for the distance of several lines before they unite. Proceeding outwards and backwards, they reach the meatus auditorius internus, and then proceed, as a single cylindrical trunk, through the aqueduct of Fallopius to emerge at the stylo-mastoid foramen, for the purpose of being distributed upon the muscles and skin of the head.

The Auditory Nerve (*nervus auditorius, acusticus, portio mollis septimi*) arises, in part, from the transverse striæ on the surface of the calamus scriptorius, and partly from the corpus restiforme, between the glosso-pharyngeal nerve and the tuber annulare, where it is also connected with the Fasciola Cinerea. At its origin it is so extremely soft as not to bear handling, and is too pulpy to present the appearance of fibres; but, becoming more distant from the medulla oblongata, it is harder and more filamentous.

This nerve is impressed on its internal face by a longitudinal furrow for the reception of the facial nerve. It passes obliquely forwards and outwards beneath the crus cerebelli, and penetrates into the meatus auditorius internus. It adheres, somewhat near its root, to the under anterior margin of the cerebellum, just behind the crus of the latter: the circumstance is considered by J. F. Meckel as a proof of its having there another origin, whereby an analogy is established between it and the two other nerves of the senses; to wit, the optic and the olfactory.

The distribution of this nerve is confined to the labyrinth of the ear.

The Eighth Pair of Nerves is composed of the Glosso-Pharyngeal, the Pneumogastric and the Spinal Accessory.[1]

[1] For an interesting course of experiments on the eighth pair, by John Reid, M. D., see Essays on Physiology, Phil. 1838, from the Edinburgh Med. and Surgical Journal.

The Glosso-Pharyngeal Nerve (*nervus glosso-pharyngeus*) arises from the posterior cord of the medulla oblongata, just above, and somewhat anterior to the superior filaments of the next nerve, with which it is very closely connected. Its filaments, which are five or six in number, spring, therefore, from the anterior margin of the corpus restiforme, or from the fissure separating it from the corpus olivare,[1] under the posterior margin of the tuber annulare.

Its filaments soon collect into a round cord, and anastomose, even in the cavity of the cranium, by a considerable branch, with the pneumogastric. It runs outwards and backwards to the foramen lacerum posterius, and goes through the same division of it that the pneumogastric does, but in its own canal of the dura mater. While traversing the foramen, two ganglia are formed on it; the upper one is the jugular (*ganglion Ehrinritteri, Mulleri*), the lower is the petrous (*ganglion Anderschi*). The first is from a line to a line and a half in length, and does not occupy the whole nerve; the second is three lines long, and involves the whole cord of the nerve.

Its general distribution is to the tongue and to the pharynx, as its name implies.

The Pneumogastric Nerve (*nervus pneumogastricus*, or *vagus*) arises from the corpus restiforme of the medulla oblongata, just behind or on the borders of the fissure separating it from the corpus olivare, somewhat above, and posterior to the highest root of the accessory nerve. It commences by a number of parallel filaments, varying in number from ten to fifteen, which are placed very near each other, so as to form two or three flattened fasciculi of half an inch or more in length. The fasciculi below adhere to the spinal accessory, and those above to the glosso-pharyngeal nerve. The fasciculi, finally, collect into a single flattened cord of one and a half lines in breadth.

This cord goes outwards and backwards to the foramen lacerum posterius, and gets through it in front of the internal jugular vein, being separated from the latter by the small spine which arises from the pars petrosa of the temporal bone. It passes through its own canal in the dura mater, being thus kept distinct from the glosso-pharyngeal, and from the accessory nerve, and in this canal the fasciculi which form it are collected into a single cylindrical trunk. After getting through the canal, it then adheres, by a close, strong, cellular substance, to the glosso-pharyngeal and to the accessory.

The general plan of distribution of the pneumogastric nerve is, as its name implies, to the organs of respiration, and to the stomach.

The Accessory Nerve (*nervus accessorius*) arises from the posterior fasciculus of the medulla oblongata, behind the nervus hypoglossus, and also from the posterior fasciculus of the medulla spinalis, sometimes as low down as the seventh cervical nerve. There are six or seven roots from the medulla spinalis, and about three or four from the medulla oblongata: the former are single, and run successively

[1] The Corpus Olivare is considered by Mr. Solly as its origin.

into the same trunk; but the latter are each composed of two branches, consisting respectively of two or more filaments. These roots are successively larger and longer, as they ascend to join the common trunk. The latter goes up between the posterior fasciculi of spinal nerves and the ligamentum denticulatum, and gets into the cavity of the cranium, behind the vertebral artery, through the foramen magnum occipitis. It is joined sometimes by a sort of knot to the posterior fasciculi, or root of the first and second cervical nerves; this knot seems to be neither after the fashion of ganglion nor plexus, but is peculiar, and looks somewhat as if one nerve were wrapped around the other.

This nerve varies in respect to the number of its roots, and the mode of their origin. In all cases, the trunk, thus formed, passes from the cranium through the foramen lacerum posterius, traversing there the dura mater, either in a sheath common to it and to the pneumogastric nerve, or in its own particular opening behind that of the latter.

Its general distribution is to the muscles and to the integuments of the neck.

The Hypoglossal Nerve (Ninth Pair, *nervus hypoglossus*) arises from the medulla oblongata, by several fasciculi placed one above the other. The roots of these fasciculi spring from the fissure which separates the corpus pyramidale from the corpus olivare, being traced to that surface of the corpus pyramidale. The fasciculi are from four to eight in number, being subject to vary in different individuals. They unite into two or three trunks, which coalesce into one after penetrating the dura mater by distinct openings, and then proceed through the anterior condyloid foramen of the occipital bone.

Santorini has observed in some cases a posterior root to the Hypoglossal nerve, and in one instance where the same was found by Mayer it had a ganglion.

The general distribution of this nerve is to the muscles of the tongue.

SECT. VII.—OF THE ARTERIES OF THE BRAIN.

The arteries of the brain, or pia mater, are derived from the two internal carotids, and from the two vertebrals.

The Internal Carotid Artery (*carotis interna*) gets into the cavity of the cranium through the carotid canal of the temporal bone, conforming itself of course to the curvature of this canal, and is brought by it to the posterior part of the body of the sphenoidal bone. In escaping from the petrous bone, it has to ascend, and also to advance somewhat, by which it is brought to the posterior part of the sella turcica. From this point it goes horizontally forwards through the cavernous sinus; and, reaching its fore part, it ascends again, and towards the fissure of Sylvius. While in the carotid canal, it gives a small branch to the tympanum of the ear, and as it lies on the side of the sella turcica it gives off the anterior and the posterior artery of the

cavernous sinus. When it reaches the anterior clinoid process, it sends off a large branch, the ophthalmic, through the optic foramen, to the parts contained within the orbit of the eye. What remains of the internal carotid is then distributed to the brain after the following order:—

There are, first of all, some small branches sent to the adjacent parts; as the pituitary gland, the infundibulum, and the lower part of the third ventricle.

The Arteria Communicans Posterior is directed backwards and inwards, and runs into the proximate branch of the basilar artery, called the posterior cerebral. There are some varieties in regard to the size and precise point of origin of the communicans posterior, which it would be needless to mention particularly. Besides this important anastomosis, the internal carotid detaches several ramuscules to the adjacent parts of the pia mater.

The Arteria Choroidea is the next branch from the internal carotid. It goes outwards and backwards, and, after detaching some minor branches, it penetrates into the inferior cornu of the lateral ventricle, by the side of the Pons Varolii, and expends itself in ramifications upon the plexus choroides.

The Arteria Callosa, or Anterior Cerebri, is detached from the internal carotid, opposite the last. It advances in front of the union of the optic nerves, converging rapidly at the same time towards its fellow. Just before the chiasm of the optic nerves, a transverse branch passes between it and its fellow. This branch, the Arteria Communicans Anterior, is of variable length and size in different subjects, being sometimes a line, and on other occasions three or four lines long. Sometimes there are two arteries, one before the other.

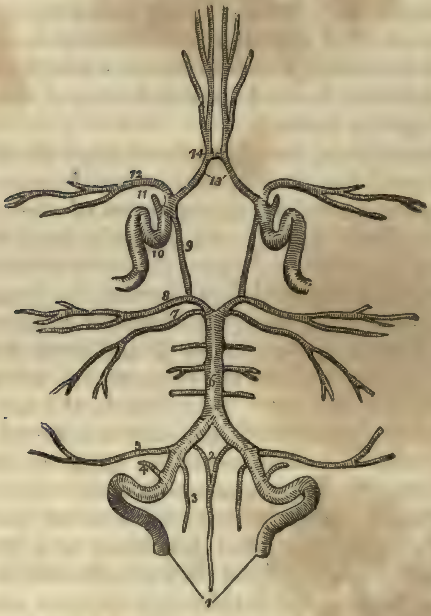
The arteria callosa then keeps near its fellow on the under surface of the hemisphere, giving out small branches; and having got on a line with the anterior margin of the corpus callosum, it ascends on the flat side of the hemisphere, and divides into anterior and into posterior twigs. The former supply the fore flat part of the hemisphere; the latter, the corpus callosum and the adjoining surface of the brain. These several branches of the arteria anterior reach as far as the upper convex surface of the brain, and there anastomose with other arteries.

The Internal Carotid may now be considered to have lost its name, and the trunk is continued as Arteria Media Cerebri. It is directed outwards, and engages in the fissure of Sylvius; while there it detaches a great number of branches to the adjoining surfaces of the anterior and of the middle lobe. Some of these branches are of considerable magnitude, and winding along the convolutions of the brain, they at length ascend to the upper surface of the hemisphere, and anastomose with the branches of the anterior and of the posterior cerebral artery.

The Vertebral Artery (*arteria vertebralis*) is a branch of the subclavian. In order to reach the cavity of the cranium, it has to traverse the foramina of the transverse processes of the six upper vertebræ of the neck. It ascends in a straight line till it reaches the second verte-

bra, but there, in order to pass through the transverse process, it takes a direction upwards and outwards. It then ascends vertically again till it has passed through the transverse process of the first vertebra. After which, it takes a horizontal course, winding around the posterior face of the upper oblique process of the same vertebra, in a depression for the purpose; and having reached the internal extremity of this process, it ascends upwards and inwards through the occipital foramen into the cavity of the cranium, perforating the dura mater just above the condyle of the occipital bone. Having got into the cranium, it is

Fig. 281.



A view of the Circle of Willis.—1. The vertebral arteries. 2. The two anterior spinal arteries. 3. Posterior spinal artery. 4. A small arterial branch. 5. The art. inferior cerebelli. 6. The basilar artery. 7. The art. superior cerebelli. 8. The art. posterior cerebri. 9. The communicans posterior. 10. The internal carotid. 11. The ophthalmic artery. 12. The middle cerebral artery. 13. The anterior cerebri. 14. The communicans anterior.

first on the side and then on the under surface of the medulla oblongata, and continues to approach its fellow till it reaches the posterior margin of the tuber annulare. At this point the two vertebral arteries coalesce, and from their union results the basilar artery.

The vertebral artery in this course, from its origin to its termination, detaches several arterioles to the heads of the adjoining muscles, to the membranes of the spinal marrow, and to the nerves as they come out of the intervertebral foramina: they are generally too small and irregular to deserve a special description. At its upper extremity, however, it sends off three branches of some consequence: the Spinalis Posterior, the Spinalis Anterior,[1] and the Inferior Cerebelli.

[1] See Arteries of Medulla Spinalis.

The Arteria Inferior Cerebelli divides shortly after its origin, or otherwise is double from the beginning. The most posterior trunk is distributed about the bottom of the fourth ventricle, on the fundamental portion of the cerebellum, and the contiguous faces of the two hemispheres or lobes of the latter. The other trunk of this artery is distributed on the under surface of the cerebellum.

The Basilar Artery (*arteria basilaris*) is on the middle line of the tuber annulare, and extends from its posterior to its anterior margin. In this course it detaches some arterioles to the tuber annulare; others to the meatus auditorius internus (*arteriæ auditivæ internæ*), which are spent upon the labyrinth, and anastomose with twigs from the internal and external carotids. At its anterior extremity it detaches on each side two considerable trunks: first, the superior artery of the cerebellum, and immediately afterwards the posterior artery of the cerebrum.

The Arteria Superior Cerebelli goes outwardly from its origin just behind the anterior edge of the tuber annulare, until it gains the front margin of the cerebellum. It then divides into several branches, some of which are distributed on the upper surface of the cerebellum and run to its posterior margin, where they anastomose with the branches of the arteria inferior: others are spent upon the substance of the cerebellum near its anterior edge.

The Posterior Artery of the Cerebrum (*arteria cerebri posterior*), one on each side, is the termination of the basilar artery. It proceeds abruptly outwards, and has gone but a few lines when it receives the arteria communicans posterior of the internal carotid. It then continues outwardly parallel with the anterior margin of the tuber annulare, and near it crosses the crus cerebri, and is then distributed, on the inferior and on the posterior part of the hemisphere of the cerebrum and of the corpus callosum. As mentioned, its branches anastomose with those of the anterior and of the middle artery of the cerebrum.

It will now be understood that an arterial circle or link encloses the chiasm of the optic nerves and the corpora albicantia. The fore and lateral parts of the circle are formed by the internal carotids and their branches; while the hind part is formed by the Basilar Artery and its bifurcation. This is the circle of Willis, and establishes a very free communication between the vessels of the two sides of the brain.

The veins of the Brain have been sufficiently alluded to in the account of the Pia Mater, and of the sinuses of the Dura Mater.

BOOK IX.

PART III.

SENSES.

To the peripheral portion of the nervous system, belong all the nerves which are sent off from the Medulla Spinalis and Encephalon, and also the Sympathetic. Some of these nerves have a special apparatus attached to their external extremities, for the purpose of augmenting and facilitating their appropriate powers of sensation; of this class are the Olfactory, the Optic, and the Auditory. Others of them, as the nerves of the tongue and of the skin, though they are the means of special sensation, yet the apparatus upon which they are spread is applied to many purposes more striking and useful than that of indicating the presence of surrounding bodies. And, lastly, the remaining nerves being by far the most numerous and large, are distributed to the muscles and to the viscera.

CHAPTER I.

OF THE ORGAN OF SMELLING, OR THE NOSE.

The senses of Vision and Hearing are so insulated in their offices, that there can be no doubt of the propriety of considering them as belonging to the peripheral portion of the nervous system: but the nose being in the human subject, attached to the function of respiration, its association here is less admissible. Without detailing the considerations which have induced me to put its description under this head, I will only mention that I have been principally actuated by its office of smelling and by its position.

In common language, the term nose is applied to the part of the organ of smelling which manifests itself externally; but a very extensive cavity of the same vertical diameter, and divided into two equal compartments, exists behind it, the form of which has been described in the account of the bones of the nose. This cavity extends from the bottom of the cranium to the roof of the mouth, and backwards to

within an inch and a quarter of the vertebræ of the neck. The nose, externally, is generally pyramidal, and has its base below; what is technically called the root of the nose is the part contiguous to the forehead. The base on each side is marked from the cheek by a semi-circular depression (*fossa semi-circularis*), which, becoming more and more shallow at its upper extremity, and increasing in breadth, is insensibly lost upon the side and point of the nose. The ala nasi is the swell of the posterior part of the base being bounded behind by the above depression. The base of the nose offers on each side an oblong oval orifice, looking downwards and having its long diameter forwards and slightly inwards. These openings are commonly about two lines below the floor of the nose, but there is a diversity in this respect; their partition is the Columna Nasi.

The Nasus Cartilagineus, or the cartilaginous portion of the nose is placed wholly at its anterior extremity, and serves to elongate the cavity in that direction. It presents a vertical cartilage, which is in continuation of the bony septum of the nostrils. On each side of this, there is an oval cartilage, and behind and below the latter, several distinct and small pieces of cartilage, which preserve the form of the alæ nasi, and constitute their foundation.

The Vertical Cartilage, or Cartilaginous Septum (*septum cartilagineum*), is placed in the middle line of the nose, and has its anterior angle projecting beyond the bony orifice of the anterior nares. Occasionally from a faulty conformation, it inclines more to one side than to the other. It adheres by its superior margin to the nasal lamella of the ethmoid and to the middle nasal suture, and behind to the anterior margin of the vomer. The inferior margin is free in the greater part of its extent, but adheres behind to the suture between the maxillary bones. The anterior margin sends out, on each side, a triangular plate (*cartilago lateralis*), the upper edge of which adheres to the inferior margin of the nasal bone, and of the nasal process of the upper maxillary. These plates form the upper part of the cartilaginous nose, extend its bridge, and from their ligamentous attachment to the bones, admit of a slight motion from side to side.

Huschké has described[1] a distinct cartilage at each side of the cartilaginous septum below, which may be found separate by maceration; he calls them the Vomerian cartilages. They are about half an inch in length, and the point of the Vomer is insinuated between them.

The Oval Cartilages, one on each side, are a sort of link, deficient or open at its posterior end. The external side is an oblong oval plate, which is directed upwards and backwards. The internal half of the link is much narrower, and proceeds backwards from the preceding part at a very acute angle; its superior margin is in contact with the septum cartilagineum; its inferior margin reaches below the latter, and its anterior extremity is in contact with its fellow, owing to the cartilaginous septum not reaching so far forwards. The place of contact of the two oval cartilages with each other forms the Tip of the

[1] Loc. cit. p. 557.

nose and the Columna Nasi, and gives the apparent thickness, before dissection, to the lower part of the septum narium.

The Alæ Nasi, or the convexities on each side of the base of the

Fig. 282.

A view of the Cartilages of the Nose.—1. The nasal bones. 2. The cartilaginous septum, anterior margin. 3. The lateral cartilages, or triangular plates. 4. The cartilages. 5. The internal portions of the oval cartilages which constitute the columna nasi. 6. The alar cartilages. 7. The nostrils.

nose, it has been said owe their shape to the presence of several small pieces (the alar cartilages), whose form, size, and number are too variable to admit of a standard description; occasionally they are all collected into but one cartilage. They serve a similar purpose with the oval cartilage, and with it are the means by which the orifice of the nostril is kept patulous. They are deposited in, and held together by a ligamentous membrane. This membrane attaches them to the lateral margin of the anterior bony naris, and also unites the upper edge of the external plate of the oval cartilage to the inferior margin of the triangular plate (*cart. lat.*) of the cartilaginous septum. It is the length and looseness of this ligament which permit such free motion to the end of the nose. In addition, there exists a small ligament described by Caldani, which goes from the posterior end of the columna nasi to the anterior inferior margin of the bony nares.

The skin which covers the upper or bony half of the nose is loosely attached, by cellular substance, to the subjacent parts; but it adheres very closely by fibrous filaments to the surface of the cartilaginous and ligamentous structure below, and is there abundantly furnished with sebaceous follicles. The exterior orifices of the latter are apparent, and are often filled with their appropriate fluid in an inspissated state, and which, when forced out by pressure, assumes the form of small worms, the blackness of the end of which is only dirt.

There are several muscles destined to move the cartilaginous structure of the nose, and which have been described among those belonging to the face. They are—

The Levator Labii Superioris Alæque Nasi, which lies upon the side of the nose, and, coming from the superior part of the nasal process and body of the upper maxillary bone, is, besides its insertion into the upper lip, connected with the ala nasi, and will draw the latter upwards.

The Compressor Naris, which, arising from the ala nasi by a small pointed beginning, is spread out upon the upper edge of the oval cartilage and upon the triangular plate of the cartilaginous septum, so as to cover them, and is inserted into its fellow on the middle line.

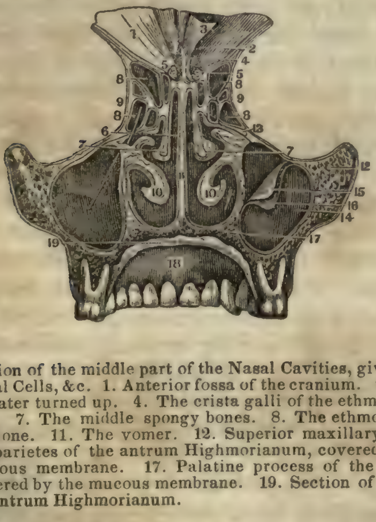
The Depressor Labii Superioris Alæque Nasi, which, by arising from the roots of the alveolar processes of the incisor and canine teeth of the upper jaw, and going to be inserted into the ala nasi, as well as into the upper lip, will draw the ala nasi downwards.

The Nasalis Labii Superioris, or Depressor Narium, which, being the pointed production from the orbicularis oris, goes into the columna nasi, and will draw the latter downwards and backwards.

The Mucous Membrane of the Nose (*membrana pituitaria, Schneideriana*) lines the whole of each side of the nose, penetrates into the several sinuses and cavities communicating with it; is continuous, at the orifice of the Nostrils, with the skin; and at the posterior nares, with the mucous membrane of the pharynx.

It is not of essential importance to trace its course from any particular point, but, for the sake of perspicuity, we may begin at the floor of the nostril which it covers in a smooth even manner, sometimes leaving a small opening into the mouth, by the foramen incisivum. This opening is called the duct of Stenson, an anatomist of the seventeenth century, who discovered it. From below it ascends on the septum narium, which it covers also smoothly without forming any fold or duplicature, and adheres so loosely that it may be detached with great facility. Behind, it covers the body of the sphenoid bone, and lines its cell; in front, it covers smoothly the os nasi and nasal

Fig. 283.



A transverse vertical section of the middle part of the Nasal Cavities, giving a posterior view of the arrangement of the Ethmoidal Cells, &c. 1. Anterior fossa of the cranium. 2. The same covered by the dura mater. 3. The dura mater turned up. 4. The crista galli of the ethmoid bone. 5. Its cribriform plate. 6. Its nasal lamella. 7. The middle spongy bones. 8. The ethmoidal cells. 9. The os planum. 10. Inferior spongy bone. 11. The vomer. 12. Superior maxillary bone. 13. Its union with the ethmoid. 14. Anterior parietes of the antrum Highmorianum, covered by its membrane. 15. Its fibrous layer. 16. Its mucous membrane. 17. Palatine process of the superior maxillary bone. 18. Roof of the mouth, covered by the mucous membrane. 19. Section of this membrane. A bristle is seen in the orifice of the antrum Highmorianum.

process of the upper maxillary bone, and also the cartilaginous nose. Above, it is reflected upon the cribriform plate of the ethmoid bone,

and blocks up all its foramina. At this point, the olfactory nerves seem to terminate on its surface and adhere very closely to it.

From the cribriform plate, the Schneiderian membrane passes to the cellular part of the ethmoid, and covers smoothly its anterior half. But behind, as it passes over the upper spongy bone, a pendulous duplicature is formed along its inferior margin, and is continued beyond the bone, backwards as far as the spheno-palatine foramen. It then lines the upper meatus and the posterior cells of the ethmoid, and is extended upon the convex surface of the middle spongy bone. At the inferior margin of the latter, it forms another loose and somewhat pendulous duplication, which does not go much beyond the posterior extremity of the bone. The membrane is then reflected into the middle meatus of the nose, and penetrates into the maxillary sinus which it lines completely. The orifice through which it enters is about the size of a crow's quill; is variable in its situation, being sometimes in the middle of the meatus, sometimes more forward, and on other occasions higher up and concealed by irregularities, in the conformation of the ethmoid. This orifice, which was found to be so large and jagged in the prepared bone, is reduced to its present size entirely by the mode of reflection of the mucous membrane over its margins. In front of the latter orifice, beneath the anterior margin of the middle turbinated bone, the mucous membrane is reflected into the anterior ethmoidal cells by one or more foramina, and through the most anterior of these cells into the frontal sinus.

From the middle meatus, this membrane passes upon the lower turbinated bone so as to cover it, and also to form a loose duplication along its inferior margin; it then lines the inferior meatus of the nose, and is continued on its floor into the part from which its description commenced. Under the anterior part of the inferior spongy bone, this membrane is continued into the lining membrane of the lachrymal sac, and there forms a fold frequently resembling a valve. Along the posterior margin of the vomer, the membrane of the nostril is continued into the corresponding one of the other side, whose arrangement is in all respects the same.

The pituitary membrane, in its structure and appearance, resembles other mucous membranes; its color, however, is naturally of a deeper red. It consists of two laminæ, which cannot be readily separated: the one next to the cavity of the nostril has the mucous structure; the exterior one is fibrous, and resembles the periosteum of other parts of the body. This composition is best seen on the part belonging to the septum narium.

By floating the pituitary membrane in water, its mucous lamina is made to exhibit, very satisfactorily, the villous and spongy appearance. This is particularly evident on the turbinated bones. Its whole surface is studded with pits or follicles of various sizes, irregularly arranged and resembling pricks made into a plastic substance with the point of a pin. From these cavities or cryptæ proceeds the mucus of the nose. In the thickness of the pituitary membrane, there exist numerous and thickly set glands, of a size so small that they escape the unassisted eye, but their existence is generally admitted, both on the authority of

anatomists who have described them,[1] and on the principle of their being always the concomitants of mucous membranes.[2]

Fig. 284.

A view of the External Parietes of the Left Nostril, as given by the removal of the septum.—1, 2. Sections of the cartilage of the nose. 3. The hollow on the inner side of the ala nasi, with the hairs and mucous follicles there found. 4. The rounded prominence where the skin and mucous membrane unite. 5. The inferior spongy bone. 6. The middle spongy bone. 7, 8. The superior spongy bone. 9. The inferior meatus of the nose. 10. The middle meatus. 11. The superior meatus. 12. An elongated projection which separates the nose from the pharynx. 13. The opening of the Eustachian tube. 14. Left half of the velum pendulum palati.

These glands, according to Valentin, in some parts of the nose consist of contorted tubes, resembling somewhat microscopic intestines; and which are surrounded and separated by circular filaments of cellular substance. The glands are especially well developed at the posterior and inferior part of the septum narium.

The surface of the Schneiderian membrane is protected by an epithelium, which, in the fore part of the nose, is laminated, but elsewhere and in the sinuses is covered with vibratile cilia.

It is owing to the great abundance of blood-vessels in this membrane, to their very superficial course, and to the habitual residence of blood in them, that it always presents a deep red color in the living state. These blood-vessels bleed very freely from slight mechanical causes, and are also disposed to congestions, which are relieved by the blood being poured out through their exhalant orifices, without laceration or any solution of continuity.

Though the description just given corresponds with the texture, generally, of the pituitary membrane, yet there are modifications of the latter at particular points which it does not fully suit. For example, at the anterior orifice of the nostril it is insensibly changed into a thin skin, furnished in the male adult with stiff hairs (*vibrissæ*): and in all the sinuses it is more thin and white than elsewhere, being also smooth and shining, and not presenting clearly the little pits which are so distinct in the nose. The surface which adheres to the sides of the sinuses resembles condensed but very thin cellular membrane, and is so loosely attached that it peels off with a very inconsiderable force. According to Henlé, the mucous membrane of the sinuses is formed merely by a delicate periosteum covered by ciliated epithelium. When the mem-

[1] Ruyschii, Epist. Anat. Probl. vii. Mayer. [2] Bichat, Anat. Descrip.

brane of the sinuses is inflamed, it then thickens, admits more red blood, and is thus brought to resemble the pituitary elsewhere.

It is extremely difficult to assign a proper use to the sinuses bordering on and entering into the nose; for, according to Dessault, the sensation of smell does not exist in them. Bichat believed that they, by being filled with air charged with odorous particles, were reservoirs of the latter, serving to prolong the sensation of smell, which would have been too fugitive if it had depended only on the passage of air during respiration. Another problem in regard to these cavities is the manner in which they discharge the mucus which they secrete. Perfectly rigid and unyielding, and so situated that the most frequent attitudes of the head would rather serve to retain than to discharge the contents of most of them by gravitation, we yet seldom see their surface more than smeared with mucus, and accumulations of it are quite uncommon, except in the diseased state. They may have been introduced principally for the purpose of extending the area of the face, for the origin of muscles and the accommodation of the senses, but with the least supply of bony matter, so as to economize the latter as we see so often accomplished elsewhere. The secretion in them, it is to be observed, is much less abundant than it is in the nose, and is probably not much more than a halitus.

Of the Nerves of the Pituitary Membrane.[1]

The Pituitary Membrane is furnished with nerves from two sources; from the olfactory, and from the fifth pair.

The Olfactory Nerve having formed its Bulb, which reposes in the ethmoidal fossa, sends off from the under surface of the bulb the succession of filaments which penetrate to the nose through the cribriform plate of the ethmoidal bone. The latter, when examined from the upper surface, has its foramina arranged into two rows, one next to the crista galli, and the other next to the cellular portion of the ethmoid. Each row consists of about six or eight foramina, and between these rows there are other foramina, smaller, and not so much in a line with each other. The same cribriform foramina, when examined from the cavity of the nose, are more numerous, especially those belonging to the first two rows, in consequence of the latter branching out below into several canals, which may be seen very distinctly on the side of the base of the nasal lamella, and on that of the cellular portion of the ethmoid.

The distribution of the olfactory nerve corresponds with this arrangement of the cribriform plate; but it has three rows of branches proceeding from the under surface of its bulb, each branch going through its appropriate foramen, and subdividing in it; but sometimes two filaments pass through the same foramen. In a short space after their origin, they become invested by sheaths of the dura mater, which are extended a considerable distance, and which, by a close adhesion to the nerves, make them appear much larger below than they are at the roots. When the nerves reach the cavity of the nose, they anastomose together,

[1] Antonii Scarpa, Anatom. Annotationes, lib. ii.

and descending between the bone and the pituitary membrane, they ramify into an infinitude of small branches, the terminating filaments of which reach the nasal surface of the membrane.

The Internal Branches, or those next to the crista galli, diverge from the cribriform plate, and pass downward between the septum and the pituitary membrane: where they first appear in the nose, there are some few adhesions or anastomoses between them; but their filaments afterwards keep perfectly distinct, and, spreading themselves out on the pituitary membrane of the septum, make an appearance resembling a flat camel's hair pencil. The middle ones are the longest, and may be traced almost to the floor of the nose; the anterior are somewhat shorter; the posterior do not reach obviously below the middle of the septum.

The External Branches have a very different mode of distribution. While still in their canals, they divide into many filaments, which anastomose frequently with each other, and when they have fairly got into the cavity of the nose, the same frequency of anastomosis continues, so that they form a net-work of numerous and small meshes, which prevails from the cribriform plate to the inferior margin of the middle turbinated bone. Their filaments cannot be traced below the latter line, and therefore do not descend so low as the filaments of the internal row, neither are they so close to each other. They do not penetrate to the ethmoidal cells. The posterior ones are very abundant on the upper turbinated bone, and incline backwards in their descent: the anterior are also abundant on the flat anterior half of the ethmoid, and when they get below the line of the upper meatus, they extend backwards to the posterior end of the middle turbinated bone, and to its inferior margin. On this bone they are less abundant than above it, their meshes are larger, and their distribution is confined to the Schneiderian membrane covering its convex surface.

The filaments of the Middle row from the Bulb of the Olfactory nerve, associate themselves indiscriminately with those of the external and of the internal row, according to local convenience.

The other nerves of the Pituitary Membrane come from the first, and from the second branch of the Trigeminus. The first branch of the latter gives off from its nasal branch the nerve called Internal Nasal, which penetrates from the orbit into the cavity of the cranium, through the anterior internal orbitary foramen, and lies covered by the dura mater, at the side of the crista galli; thence it passes into the cavity of the nose through the most anterior external foramen of the cribriform plate.

The Internal Nasal Nerve (*nasalis internus*) having got into the nose, divides into two fasciculi, an internal and an external. The internal descends along the anterior margin of the septum, between the mucous membrane and the bone, and, after a short course, is divided into two filaments, one of which, applying itself to the posterior face of the os nasi, terminates by smaller filaments in the integuments of the lower part of the nose; the other filament continues along the margin of the septum to its lower part, where it terminates by smaller filaments. The external fasciculus of the Nasalis Internus gives off

early a filament, which descends along a groove on the posterior face of the nasal bone, and winding over the lower edge of the latter, or passing through a foramen in it, is lost upon the integuments of the corresponding part of the nose. Other filaments from the external fasciculus descend upon the mucous membrane, along the external anterior part of the nose on that which corresponds with the nasal process of the upper maxilla, and terminate near the anterior extremity of the inferior spongy bone: they are three or four in number. The internal nasal nerve is also said to send one or more filaments to the frontal sinus, but they are so fine that doubts of their existence are entertained by Bichat, though they are admitted by J. F. Meckel.

The Spheno-Palatine Ganglion, a part of the second branch of the Trigeminus, detaches to the nose, through the spheno-palatine foramen, several nerves. One of these, discovered by Cotunnius, and admirably delineated by Scarpa and by John Hunter, called the Naso-palatine (*naso-palatinus*), runs across the front of the sphenoidal sinus to the upper posterior part of the septum narium, beneath the mucous membrane. It then descends obliquely along the septum to the foramen incisivum, and passes through it to the roof of the mouth. In many cases, however, a distinct foramen is formed in the middle palate suture for it, anterior to the foramen incisivum. The nerve of the left side is anterior to that on the right. When the two reach the roof of the mouth, or are near it, they unite to form a little swelling called the Naso-palatine ganglion,[1] from which several filaments arise, and are spent upon the membranous caruncle at this point, and upon the contiguous part of the palatine membrane.

The spheno-palatine ganglion sends several filaments to the mucous membrane of the upper spongy bone and of the upper meatus, and to that of the posterior end of the middle spongy bone. The palatine nerve, one of its largest branches, in descending along the posterior palatine canal to the soft palate of the mouth, also contributes to the supply of nerves to the nose. Shortly after it has arisen from the ganglion, it sends one or more filaments to the middle spongy bone, and to the superior part of the lower spongy bone, and when it has got, in its descent, on a level with the posterior end of the latter, it detaches another filament, which supplies the mucous membrane along the inferior margin of this bone.

In regard to the termination of these several orders of nerves, it is generally held that the filaments of the olfactory end in brush-like extremities. Klencke,[2] however, asserts that on the septum they form distinctly cylindrical filaments, ending in fine loops, while elsewhere they end by a very delicate capillary net-work. Huschke[3] claims to have observed the arteries of the Schneiderian membrane attended by filaments of the sympathetic, and has advanced the opinion that the naso-palatine nerve is itself only the upper end of the great sympathetic. It is probable that the filaments of the fifth pair belonging to the nose end, as elsewhere, by terminal loops.

An opinion advanced by Mery, about the close of the seventeenth century, was revived by M. Magendie, of Paris, that the olfactory

[1] J. Cloquet, Anat. [2] Huschke, loc. cit. p. 565. [3] Loc. cit.

nerves are not those which communicate the impressions of odorous bodies. In contradiction, however, to his experiments, it should be stated that several respectable anatomists have seen cases where the privation of the sense of smell, during life, was found, upon examination after death, to be attended with the absence of the olfactory nerves.

Of the Blood-Vessels of the Nose.

The extreme vascularity of the Schneiderian Membrane is derived from several sources. The Internal Maxillary Artery sends through the Spheno-Palatine Foramen a large branch, which is distributed upon the septum and upon the spongy bones. The superior palatine artery supplies this membrane with one or more small branches. The Ophthalmic also sends the anterior and the posterior ethmoidal branches to it, from the orbit of the eye. The Infra-orbitar artery likewise contributes to its vascularity by one or more branches, sent off in its course through the infra-orbitar canal.

The veins follow the course and distribution of the arteries. Some of them, however, unite with the trunks called emissaries of Santorini, which come from the sinuses of the dura mater through the foramen ovale and rotundum of the sphenoid bone. They are extremely superficial, with very thin parietes; hence they bleed from the most trivial causes.

CHAPTER II.

OF THE EYE, AND ITS DEPENDENCIES.

The organ of vision, which depends upon the optic nerve for its usefulness, is formed by the Ball of the Eye (*bulbus oculi*), and many Dependencies or Auxiliary parts (*tutamina oculi*). They all are situated within the orbit, and fill up its cavity.

SECT. I.—OF THE AUXILIARY PARTS OF THE EYE.

The Eyelids (*palpebræ*) are placed at the anterior orifice of the orbit, and serve to shut out the light from the eye, by their closing; and also, by their frequent motions, to sweep the front of the eyeball, so as to remove, from its transparent part, moats and dust. They are distinguished into upper and lower, and the place at each end, where the horizontal fissure between them ceases, is called their Commissure, Angle or Canthus. The angle next to the nose, or the internal, is called the Great one, and the other, the Little one.

The Internal Canthus is united to the nasal process of the superior maxillary bone by a rounded tendon, the internal palpebral ligament,

in other words, the origin of the orbicularis palpebrarum muscle. This tendon passes horizontally inwards, is nearly half an inch in length, and raises the skin into a small ridge, which may be distinctly seen and felt at this point. The External Canthus is held in place by its general attachments of cellular substance, and by the external palpebral ligament.

The upper eyelid is somewhat larger than the lower, but the structure of both is the same, for each one is formed by skin externally; next to it a plane of muscular fibres, being the orbicularis palpebrarum; then a plate of cartilage, and, lastly, a thin membrane uniting it to the eyeball.

There is nothing in the texture of the skin of the eyelid which needs description in a manner more particular than that of stating its fineness, its thinness, the looseness of its attachment to the muscle beneath by long yielding cellular substance, and the deficiency of adipose matter. The skin is rendered prominent at the superior margin of the orbit, both by the projection of the bone there, and by the presence of the corrugator supercilii muscle at its internal extremity. This prominence is furnished with an arched cluster of hairs (*supercilia*), which have their loose ends inclined horizontally outwards, and are rather more abundant at the root of the nose than externally. The supercilia of the two sides are separated commonly by a small bare space called Glabella,[1] the existence of which adds much to the calm and intellectual expression of the human countenance; whereas, the junction of the two eyebrows, by the hairs filling up this space, gives a gloomy, and occasionally a ferocious, appearance.

The margins of the eyelids are also furnished with hairs (*cilia*), the roots of which are insinuated between the skin and the layer of cartilage: the most deeply seated seem, indeed, to penetrate the latter. The hairs of the upper lid are longer and more numerous than those of the lower; they are concave upwards, while the latter are concave downwards, so that the convexities of the two ranges of hairs come in contact when the eyelids are closed. The hairs of each cilium are disposed into three or four rows, by which a long brush is formed, the central hairs of which are longer and larger than any others.

The hairs of the supercilia and of the cilia resemble one another strongly, for, when examined closely, each one will be found to have a bulbous soft root, just beyond which there is a narrow part. The middle of the hair is swollen, and its external extremity is brought to a fine point. These hairs correspond in color with the hairs of the head.

For Muscles of Eyelids, see Orbicularis and Corrugator, Vol. I.

The Palpebral Cartilages (*tarsi*) are two in number, one at the margin of each eyelid, to which they communicate a smooth, even surface, from the internal to the external commissure. They are between the orbicularis muscle and the tunica conjunctiva. The upper one is larger than the lower, resembles an oval cut in half in its long diameter, and is about six lines broad in its middle: the lower one is of a breadth, nearly uniform, of about two lines. Their internal extremities cease

[1] From Glaber, smooth.

just before they reach the puncta lachrymalia. They are attached by the internal palpebral ligament (*ligamentum palpebrale internum*), which has just been described as one of the origins of the orbicularis oculi muscle, to the nasal process of the upper maxillary bone; their external extremities cease just before their commissure, and are firmly attached to the external palpebral ligament.

These cartilages are thicker where they form the margin of the eyelids, and have there a slope or bevel, by which, when in contact, a small groove is formed on their posterior surface. From their resistance to the concentric contractions of the orbicularis, they keep the eyelid smooth, and favor its sliding upon the eyeball. Certain animals are destitute of these cartilages; when they wink, the skin, by the contraction of the orbicularis, is drawn up like the mouth of a purse.

When the orbicularis muscle is removed, a ligamentous or fibrous membrane is found passing from the external margin of the orbit to the corresponding margin of the palpebral cartilages, and separating the eyelids from the parts contained within the orbit. There is a partial decussation of the fibres of this membrane, from the external commissure of the cartilages to the adjoining edge of the orbit; it has more firmness than any other part of the membrane, and is the external palpebral ligament (*ligamentum palpebrale externum*). On the side of the internal canthus of the orbit there is no corresponding ligamentous expansion, but a few irregular fibres, which allow the masses of fat beneath to project forwards between their fasciculi.

Conjunctiva.—Below the palpebral cartilage is the fourth layer of the eyelid, the conjunctiva. It is a white, thin, and diaphanous membrane, in the uninflamed state. Beginning at the roots of the cilia, where it is continuous with the skin, it covers the posterior face of the eyelids in adhering almost immovably to the tarsi cartilages, is reflected for eight or ten lines towards the bottom of the orbit, and then passes to the eyeball, of which it covers the anterior half, not excepting the cornea. At the circumference of the latter it has a little circular elevation called the Annulus Conjunctivæ. Its reflection towards the bottom of the orbit is two or three lines deeper in the case of the upper than the lower lid. It penetrates into the lachrymal passages, to be continuous with the lining membrane of the lachrymal sac.

From this description, it is evident that the tunica conjunctiva has one surface presented against itself when the eyelids are closed; this surface is lubricated and very smooth, so as to permit a free motion of the lids and ball of the eye. The other surface is connected in its anterior half by cellular substance to the eyelids, and in its remaining part to the ball of the eye, by the same means. The name of the sclerotic fascia has latterly been used to designate this cellular substance, and is especially resorted to in reference to operations for squinting, by cutting the muscles of the eyeball. This fascia, or cellular tissue, may be traced to the bottom of the orbit at the optic foramen, and makes an investment of the several contents of the orbit. From this it is sometimes considered as consisting of two laminæ; the exterior one, being an investment especially of the muscles, is the capsule of Bonnetus; while the more interior division, being next to the globe

of the eye, is the capsule of Tenon. The conjunctiva is united rather loosely to the sclerotica till it gets near the margin of the cornea; but to the latter it adheres so firmly, and changes there so much in its texture, that it seems like a portion of the cornea.

The conjunctiva, from its continuity with the skin and the lining membrane of the nose, from its sympathies with them, from the nature of the discharge from it, and from its extreme sensibility, is ranked by Bichat among the mucous membranes. It has, however, some peculiarities in its structure, for it is entirely deficient in villosities on the eyeball, unless near the angle of reflection; but on the eyelids, and especially the palpebral cartilages, the villosities are very easily seen in an inflamed state or when erected by an injection. The conjunctiva is most abundantly furnished with capillary vessels, and they do not obviously admit red blood, but in a state of irritation; except just among the glands of Meibomius, where most persons have them somewhat turgid with blood. In a minute injection, this vascularity is fully and beautifully evolved on the tarsi cartilages.

The conjunctiva has a covering of Epithelium, and is stated by Valentin[1] to be destitute of mucous follicles, the secretion of the lachrymal gland supplying the place of mucus. This observation is, however, opposed to that of Krause, who says that they are very numerous at the conjunctival reflection, forming little masses there, and then scattering as they approach the tarsi cartilages. Its epithelium is made according to Henlé, of fine polyhedral nucleated cells.

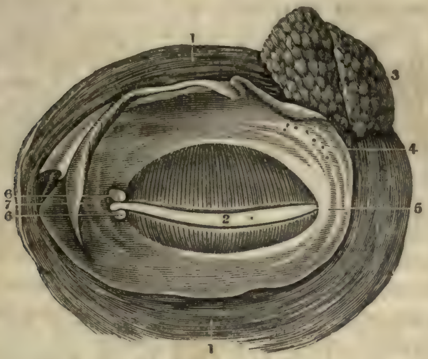
Glandulæ Palpebrarum.—These bodies, also called the glands of Meibomius, from an anatomist who has described them particularly, are situated at the margin of each eyelid; between its cartilage, in which they are received in small grooves, and the conjunctiva. They are about two or three lines long, and appear like small, white, serpentine threads, running at right angles to the margin of the lid, near to, and parallel with one another. When examined closely, it will be found that a Gland of Meibomius is a long tube having small cœcal tubes or cells discharging into its sides, and which occasion the serpentine appearance. They are more abundant on the upper than on the lower lid. They terminate by a row of small orifices in the margin of the lid, just behind the cilia. For preventing the overflowing of the tears, and the sticking together of the eyelids, they discharge an unctuous fluid, which may be made manifest by squeezing them. Their secretion is occasionally much augmented, and then has a large quantity of serum and glutinous matter in it: in this case, the evaporation of the serum makes it adhesive, and causes the eyelids to adhere after they have been closed for some time, as in sleep.

The Lachrymal Caruncle (*caruncula lachrymalis*) is placed in the angle formed by the internal junction of the eyelids. It is a red-colored tubercle, differing in size in different individuals, but commonly as large as a grain of wheat. It is conical, and obtains its redness from the conjunctiva being reflected over it: when accurately examined,

[1] Müller's Physiol. p. 417, Lond. 1840.

it will be found to consist in a group of sebaceous glands; of which, according to some anatomists, there are seven ranged two in a row,

Fig. 285.



A posterior view of the Eyelids and Lachrymal Gland.—1, 1. The orbicularis palpebrarum muscle. 2. The borders of the lids. 3. The lachrymal gland. 4. Its ducts opening in the upper lid. 5. The conjunctiva covering the lids. 6. The puncta lachrymalia. 7. The lachrymal caruncle as seen from behind.

and one on the top of the others. The surface of this body is beset with very fine hairs, and the orifices in it are distinguishable with a glass.

The Semilunar Valve, or Fold (*plica semilunaris*), is situated immediately at the outer margin of the caruncle. It has the form of a triangle, the point of which runs into the caruncle, and the base, which is somewhat crescentic, is directed towards the eye. It is a duplicature of the conjunctiva; becomes very manifest in an examination from behind, and, in some persons, has its base furnished with a very small strip of cartilage.[1] I have seen several cases of the kind very well marked; they occur oftener in Africans, according to my personal experience; in them the Plica is also colored not unfrequently with pigmentum nigrum. Between the base and the caruncle this fold is formed into a number of small loose wrinkles, which disappear when the eye is very much abducted.

This body, in the human subject, is evidently intended to permit to the eye a great freedom of abduction. Its analogy, however, with the third eyelid of animals is very striking, and the difference is rather in the full development of the latter than in the organization. It is very properly remarked by J. F. Meckel, that, in descending the scale of animals, the third eyelid is always in an inverse ratio to the other two, till it ends by being a complete substitute for them.

Surrounding the Lachrymal caruncle may be observed a depression on the adjoining part of the plica semilunaris. Into this depression the puncta lachrymalia are directed, and there play up and down.

[1] Meckel.

The tears accumulate in it, from which cause the depression is called Lacus Lachrymalis.

Muscles.

The Musculus Levator Palpebræ Superioris is placed in the superior part of the orbit. It arises by a small round tendon from the upper margin of the optic foramen, and, becoming fleshy, it expands itself into a long thin triangle, of which the base is before.

Terminating in front by a thin tendinous expansion, it is inserted into the superior margin of the upper palpebral cartilage; but some of its fibres continue on between the latter and the orbicularis to the lower edge of the cartilage. It covers the rectus superior muscle.

It raises the upper lid, by drawing it towards the bottom of the orbit.

There are six muscles concerned in moving the eyeball, four of which, from their direction, are said to be straight; and the other two, for the same reason, are called oblique. With the exception of the inferior oblique, they all arise tendinously from the bottom of the orbit. Being inserted tendinously into the Sclerotica, their tendons pass on for two lines or so, in continuing this connection beyond its commencement.

1. The Rectus Oculi Superior, being placed immediately below the levator palpebræ, arises from the superior margin of the optic foramen. It runs forwards, increasing somewhat in breadth, and is inserted by a broad thin tendon into the sclerotica, four lines from the cornea.

It turns the eye upwards.

2. The Rectus Oculi Externus arises from the external margin of the optic foramen and from the common tendon of that part called the Ligament of Zinn, connected with the other muscles. It then advances along the middle of the external wall of the orbit, near the periosteum, to which it adheres slightly, and is, finally, inserted, by a thin broad tendon, into the external side of the sclerotica, about four lines from the cornea.

It abducts the eye, or turns it outwards.

3. The Rectus Oculi Inferior arises also from the optic foramen, at its inferior margin, and lies upon the floor of the orbit as it advances forwards. It is inserted, tendinous, into the under surface of the sclerotica, three lines from the cornea.

It depresses the eye, or turns it downwards.

4. The Rectus Oculi Internus arises from the internal margin of the optic foramen, and goes forwards along the internal wall of the orbit, being separated from it by a layer of adipose matter. It is inserted, by a tendinous expansion, into the inner side of the sclerotica, three lines from the cornea.

It adducts the eye, or turns it inwards.

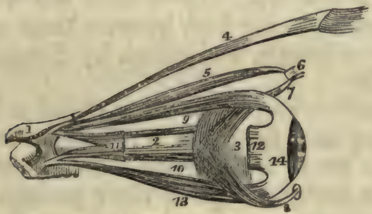
5. The Obliquus Oculi Superior is placed along the upper internal angle of the orbit. It arises from the corresponding margin of the optic foramen, by a small round tendon; it then advances forwards, and when it has got near the margin of the orbit, it is converted into a long round tendon.

The tendon passes through a fibro-cartilaginous loop which is formed for it, just at the inner margin of the supra-orbitary foramen, and is connected to the loop by long loose cellular substance, which permits it to play freely backwards and forwards. The tendon from this point changes its direction by going backwards and outwards; it also becomes more flat, and is then inserted into the upper face of the sclerotica near its middle, just beneath the internal margin of the rectus superior muscle.

This muscle is the longest, but the most delicate of those belong to the eyeball. According to Sœmmering, it draws "the eyeball forwards, and towards the internal canthus, and directs the pupil towards the cheek. By the aid of the inferior oblique, it draws the eyeball towards the nose: it expresses pride: it appears to be greatly excited in anger."[1]

The preceding muscles are all connected, either directly or indirectly, with the theca of the optic nerve by the Ligament of Zinn.

Fig. 286.



A view of the Muscles of the Eyeball, taken from the outer side of the Right Orbit.—1. A small portion of the sphenoid bone around the entrance of the optic nerve into the orbit. 2. The optic nerve. 3 The globe of the eye. 4. The levator palpebræ muscle. 5. The superior oblique muscle. 6. Its cartilaginous pulley. 7. Its reflected tendon. 8. The inferior oblique muscle; a piece of its bony origin is broken off. 9. The superior rectus muscle. 10. The internal rectus almost concealed by the optic nerve. 11. Part of the external rectus showing its two heads. 12. The extremity of the external rectus at its insertion; the intermediate portion of the muscle having been removed. 13. The inferior rectus muscle. 14. The sclerotic coat.

6. The Obliquus Oculi Inferior is at the bottom of the orbit.

It arises, by a small tendinous beginning, from the os maxillare superius at the side of the os unguis, and, increasing in size, it goes below the rectus inferior outwards and backwards, and gets between the eyeball and the rectus externus. It is then inserted into the outer face of the sclerotica, about half way between the optic nerve and the cornea.

It causes the eye to revolve on its axis, and turns the cornea towards the nose. Its action, however, is much modified by that of the other muscles.

As the revolving axis of the eye is a line passing from the centre of

[1] Bulbum in priora et angulum internum versus movet; pupillam deorsum ad genam dirigit; juvante musculo obliquuo inferiore bulbum nasum versus trahit; animi fastum exprimit; ira valde commoveri videtur.

the optic nerve, forwards and outwards, it will be found that each of the oblique muscles is inserted, at right angles, to this line. Consequently, their simple and unmodified action is to produce a revolution of the eye on its axis, in the line of their insertion; the first making the eye roll inwards, and the latter outwards, on the two poles; they, therefore, are strictly antagonists.

Of the Lachrymal Apparatus.

The apparatus for the tears (*organa lachrymalia, viæ lachrymales*) consists in the Lachrymal Gland, the Lachrymal Ducts, the Lachrymal Sac, and a few other parts.

The Lachrymal Gland (*glandula lachrymalis*) is situated in the orbit, immediately below and within the external angular process of the os frontis. It secretes the moisture that lubricates the eyelids and eyeball, and which, when it becomes abundant, is called the Tears. It is a flattened oblong or oval body, convex above and concave below, of ten lines in length, six in width, and about two lines at its thickest part, for its edges are somewhat bevelled. It may be considered as divided into two parts or lobes, of which the superior is the larger, and occupies the depression attributed to it in the frontal bone, while the inferior, being the smaller, is placed at the anterior margin of the depression. It is lined below by the conjunctiva, and is protected in front by the margin of the orbit which it touches. These lobes are frequently marked off by a ligamentous band passing from between them to the external angular process of the os frontis, and called, by Sœmmering, Ligamentum Gland. Lachrymalis.

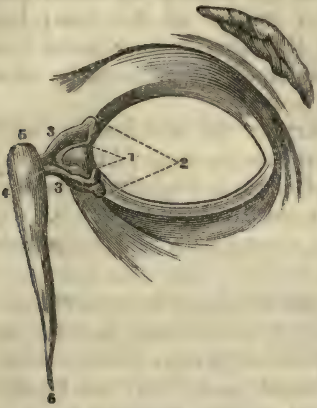
This gland resembles much a salivary gland in its light pink color, and in its consisting in a congeries of lobules united by cellular substance. Unless we are to consider the latter as such, it has no regular capsule. From the lachrymal gland there proceed six or seven excretory canals, extremely fine, and found with so much difficulty that many distinguished anatomists have sought for them in vain.[1] The orifices of these ducts have been laid down by Sœmmering, as equi-distant; forming in the conjunctiva a row half an inch long, and parallel with the superior margin of the upper tarsus cartilage, beginning a quarter of an inch above its external end and going inwards. By squeezing the gland, small drops like tears will appear on the nearest surface of the conjunctiva, but not in the regular order laid down by anatomists for the lachrymal orifices.

The Lachrymal Ducts (*canaliculi lachrymales*) are situated immediately beneath the skin, at the internal commissure of the eyelids, in their posterior margin, and behind the orbicularis muscle. There is one for each eyelid. They are about half an inch long, though the lower one is rather longer than the upper.

[1] These are Morgagni, Haller, Zinn, and Duverney. Meckel, Sœmmering, and many others, speak with all confidence concerning them. Bichat admits that he only acknowledges their existence inductively. Dr. Monro, of Edinburgh, claims to have discovered them by plunging the eye into a colored fluid which was absorbed by them. Dr. W. Hunter seems to have a prior claim to Dr. Monro. See Med. Comment. p. 54. Mascagni also acknowledges their existence: Prodromo della Grande Anatomia, vol. i. p. 60.

The lachrymal ducts commence at a small elevation (*papilla lachrymalis*) of the margin of each eyelid, bordering immediately upon the

Fig. 287.



A view of the shape and position of the Lachrymal Canals.—1. The puncta lachrymalia or openings of the lachrymal canals in the lids. 2. The cul-de-sac at the orbital end of the canal. 3. The course of each canal to the saccus lachrymalis. 4, 5. The saccus lachrymalis. 6. The lower part of the ductus ad nasum.

internal end of the tarsus cartilage, but perfectly distinct from it. This elevation is conical, has a vermicular motion during life from a special muscular arrangement, and points towards the ball of the eye; in its centre is a very small foramen, called the Punctum Lachrymale, which is the beginning of the lachrymal duct. The punctum is about a line in length; and enlarging in its course, it runs at right angles to the duct into which it empties, and of which it may be called the Orbital Orifice: the upper one will, therefore, ascend, and the lower one descend; the lower one is more distant from the internal commissure of the eyelids.

The lachrymal ducts are much larger than the puncta, and are in their whole course about one line in diameter. At their orbital extremities, they go rather beyond the punctum lachrymale so as to form a small cul-de-sac. These canals converge, and having got to the internal angle of the eyelid, they are there placed behind the internal palpebral ligament. They then discharge, by distinct orifices, but very near each other, into the lachrymal sac at its external anterior part. At the place of their entrance there is a small spheroidal excavation or sinus into which they empty (*sinus lachrymale*), the free edges of which make a circular doubling, apt to arrest an instrument in its passage from the punctum to the Lachrymal sac. Where they enter, they form a small round projection into the interior of this spheroidal cavity. When the eyelids are closed, the lachrymal ducts are horizontal and nearly parallel, but when the eye is open the upper duct is elevated, and thereby becomes oblique; it is hence more in line for the introduction of instruments into the lachrymal sac; though I consider this feat more easy at the lower punctum from the support given at the margin of the orbit.

The Lachrymal Sac (*saccus lachrymalis*) is placed at the internal canthus of the orbit, in the depression of the os unguis, and of the nasal process of the upper maxillary bone. It is an oblong cylindroid cavity, and extends from the transverse facial suture to the anterior extremity of the inferior meatus of the nose; being concealed there by the anterior part of the inferior turbinated bone. It is crossed at its front part by the tendon of the orbicularis, which, with a few fibres of this muscle, adheres to it.

The course of the lachrymal sac is at first slightly forwards or directly downwards in the descent to the nose; but when it reaches the lower part of the orbit, it is afterwards slightly backwards: so that it may be considered as forming an obtuse angle forwards. It also decreases somewhat in size from above downwards, and at its lower orifice is flattened from side to side.

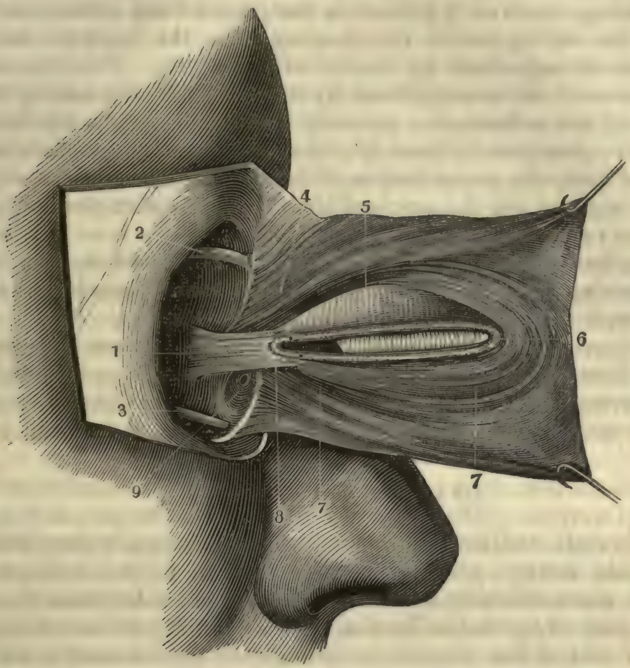
The lachrymal sac consists in two membranes; an exterior fibrous one continuous with the periosteum of the contiguous bones, and an interior mucous one, which is thick, villous, of a red color, from the abundance of its blood-vessels, and abounding in mucous follicles or glands. The interior is continuous above with the lachrymal ducts, and below with the Schneiderian membrane. On a line with the floor of the orbit, this internal membrane is thrown into a circular duplicature, considered by some anatomists as forming the proper boundary of the lachrymal sac; all below this being called by them *Nasal Canal* (*ductus ad nasum*). The distinction is rather arbitrary, and, in some degree, hurtful to clearness of description: a much better plan is to call the part above the valve the orbital portion of the sac, and the part below the valve its nasal portion. Generally there is another valve at the nasal orifice, formed by a duplication of the Schneiderian membrane. This is either circular or consists of two semi-elliptical folds, the diameters of which come into contact; the slit between them being vertical. Sometimes there is a second valve about three lines below the first.

The *Tensor Tarsi* is a small muscle on the orbital face of the lachrymal sac, and of which I gave a detailed account some years ago.[1] It arises from the posterior superior part of the os unguis, just in advance of the vertical suture between the os planum and the os unguis. Having advanced three lines, it bifurcates; one bifurcation is inserted along the upper lachrymal duct, and terminates at its punctum, or near it; and the lower bifurcation has the same relation to the lower lachrymal duct. The base of the caruncula lachrymalis is placed in the angle of the bifurcation. The superior and the inferior margin of the muscles touch the corresponding fibres of the orbicularis palpebrarum, where the latter is connected with the margin of the internal canthus of the orbit; but may be readily distinguished by their horizontal course. The nasal face of this muscle adheres very closely to that portion of the sac which it covers, and also the lachrymal ducts. The lachrymal sac rises about a line above its superior margin, and extends in the orbit four lines below its inferior margin. The orbital

[1] Philadelphia Journal of Med. and Phys. Sciences, 1824.

face of the muscle is covered by a lamina of cellular membrane, and between this lamina and the ball of the eye are placed the valvula semilunaris, and a considerable quantity of adipose matter.

Fig. 288.



A view from behind, on the right side of the Tensor Tarsi or Muscle of Horner.—1. Origin of the tensor tarsi muscle, from the superior part of the os unguis, just in advance of the vertical suture, between the os planum and the os unguis. 2. Superior oblique muscle of the eyeball. 3. Inferior oblique muscle of the eyeball. 4. Origin of the orbicularis palpebrarum, from the nasal process of the os maxillare superius, internal angular process of the os frontis, and the contiguous part of the os unguis—also along the whole superior margin of the internal palpebral ligament. 5. A portion of the palpebral conjunctiva. 6. External palpebral ligament and canthus of the eyelid. 7, 7. Lower portion and terminating fibres of the orbicularis palpebrarum. 8. Bifurcation of the tensor tarsi muscle at the base of the caruncula lachrymalis. The insertions of the muscle near the puncta are also shown. 9. Lachrymal sac.

As the bifurcated extremities of the muscle follow the course of the lachrymal ducts, they are covered by the tunica conjunctiva. When this muscle is examined from behind, the eyelids being *in situ*, it becomes obvious that it is concave on its orbital surface, and, consequently, convex on the nasal; that the muscle is an oblong body, half an inch in length, and about three lines wide, bifurcated at one end; and that it arises much deeper from the orbit than any acknowledged origin of the orbicularis. The superior fork, however, has a few of its fibres blended with the orbicularis.

In regard to the use of this muscle: its attachment to the posterior face of the sac is such that it draws the orbital part of the sac away from the nasal, and dilates the sac, from the nasal face of the latter being fixed to the bones. As this muscle is cylindrically concave on its orbital side, it is evident that, when it contracts, the fibres become

straight, or nearly so, like the fibres of the diaphragm, and the cavity of the sac is enlarged after the same manner as the cavity of the thorax. A tendency to a vacuum being thus produced by it, the valves or folds of the internal membrane of the sac resist so that the vacuum is filled more readily from the puncta than from the nose; and the puncta being continually bathed in the tears of the lacus lachrymalis, both in the waking and in the sleeping state, the tears are constantly propelled through them by atmospheric pressure. The evacuation of the sac is no doubt accomplished by its own elasticity, and by the contraction of the orbicularis; probably in a chief degree by the latter, because, in persons who have epiphora, or a tendency to obstruction in the nasal duct, the accumulation of tears and matter principally takes place at night, when the action of the orbicularis is suspended by sleep. For these reasons, we should argue that this little muscle is active at all times, both night and day. To the late Dr. Physick I am indebted for suggesting another use for it; to wit, that of keeping the lids in contact with the ball of the eye.

Some persons possess unusual voluntary power over this muscle, of which I have seen several examples. In each instance the individual could shorten so much the internal angle of the eyelids, as to conceal it, along with the puncta, in the internal canthus of the orbit.[1]

Of the Arteries of the Orbit.

The Eyeball, and its auxiliary parts, are principally supplied by the Ophthalmic Artery, which, as was mentioned in the account of the Brain, is a considerable branch given off by the Internal Carotid at the fore part of the Sella Turcica. This branch gets into the orbit on the outer side of the optic nerve through the optic foramen, and, after a short course, crosses obliquely above the optic nerve, so as to pass to the internal side of the orbit. It sends off many small trunks, which are very inconstant both in their size and origin; they are the following:—

1. Arteria Lachrymalis arises, commonly, soon after the ophthalmic has got into the orbit; it goes forwards between the rectus superior and the rectus externus muscle, to which it distributes arterioles; it then reaches the lachrymal gland, and, having left branches with it, what remains issues out at the external angle of the eye, so as to supply the contiguous part of the upper eyelid.

[1] Having labored, first of all, to convince the profession of the existence of this muscle, the next step, as is usual on such occasions, was to vindicate my own pretensions to its discovery and to attempt to remove such objections as required attention. For the arguments on this subject, see the Philadelphia Journal of Medical and Physical Sciences, of Nov. 1824, edited by Professor Chapman. My claims have been unequivocally admitted by Messrs. Breschet and Jourdan, of Paris, anatomists of unusual distinction, in the translation which they have made of J. F. Meckel's Manual of Anatomy, vol. iii. p. 219; by Géry, in the Mélanges de Chirurgie étrangère, Geneva, 1824, p. 415; and by Professor Giuseppe Trasmondi, in the Arcadica Journal of Rome, &c. vol. xix. p. 1, 1823. This muscle is also now admitted into the myology of the most classical works on Anatomy, the highest of which may be considered the latest edition of Sœmmering, de Corp. Hum. Fabr., under the title of Encyclopédie Anatomique, Paris, 1843.

2. Arteriæ Ciliares. According to Sœmmering, before the origin of the lachrymal artery, the ophthalmic detaches from one to three ciliary, which penetrate into the ball of the eye near the optic nerve. Other arteries of the same class arise subsequently from the ophthalmic, and occasionally some of them from the lachrymal itself. They go to the choroid coat of the eyeball and to the iris.

3. The Arteria Centralis Retinæ arises from among the cluster of ciliary arteries, and, like them, has no invariable root. It penetrates the optic nerve about the middle of its orbitar portion, and, going in its centre, gets into the eye through the cribriform part of the sclerotica. It is then distributed by ramuscules to the retina, to the tunica hyaloidea, and to the capsule of the lens.

4. The Arteria Ethmoidea Posterior is inconstant in existence, and comes at one time from the trunk, at another from a branch of the ophthalmic. It passes over the superior oblique muscle, and, penetrating through the posterior orbitary foramen, is spent by arterioles upon the neighboring parts of the dura mater, and upon the posterior ethmoidal cells, where it anastomoses upon the Schneiderian membrane, with branches from the internal maxillary.

5. Arteriæ Musculares. Of these there are two: one of them, the inferior, sends branches to the rectus internus, rectus inferior, and obliquus inferior oculi; also to the lachrymal sac, and to the parts about the bottom of the orbit. It occasionally detaches some of the ciliary arteries. The superior muscular branch is also called the Supra-Orbitar. It supplies the muscles of the superior part of the orbit, and then issuing through the supra-orbitary foramen, it is spent in arterioles, upon the os frontis and its periosteum, and upon the orbicularis oculi, corrugator supercilii, and occipito-frontalis. It anastomoses there with other branches of the ophthalmic, and with the temporal artery.

It is usual for the anterior ciliary arteries to come from the muscular branches.

The Ophthalmic Artery, after having detached all the aforesaid branches, is much diminished in volume, and, advancing along the internal part of the orbit, its next branch is—

6. The Arteria Ethmoidea Anterior, which dips into the anterior internal orbitary foramen, and is divided into small branches, some of which are spent upon the adjacent portion of the dura mater, others upon the frontal sinus and the anterior ethmoidal cells. Some of these branches penetrate from the cranium through the cribriform plate into the nose, and, ramifying upon the Schneiderian membrane, anastomose with the internal maxillary.

7. The Arteriæ Palpebrales are two in number: they come sometimes from a common trunk, and on other occasions arise separately. One is the Superior, and the other the Inferior. The latter arises first, and

is distributed to the conjunctiva, the caruncula lachrymalis, lachrymal sac, and finishes by many small branches to the lower eyelid, that anastomose with the infra-orbitar artery, so as to form the lower tarsal arch. It also anastomoses with the lachrymal artery by its extreme branches.

The Superior Palpebral Artery also distributes branches to the conjunctiva, sac, and caruncle; it then emerges above the inner palpebral ligament, around the margin of the superior eyelid, and forms, along with the lachrymal and the supra-orbitar artery, the superior tarsal arch, which distributes small branches, in great profusion, to the orbicularis muscle, and to the structure generally, of this lid. It anastomoses, externally, with the lower palpebral artery.

8. The Arteria Nasalis is sometimes a well-marked continuation of the ophthalmic. It passes out of the orbit at its internal canthus, above the internal palpebral ligament, and anastomoses at the root of the nose with the facial artery. It is distributed to the side of the nose, and to the lower part of the forehead. Its chief contribution to the eyelids is at the internal end of the orbicularis, where it anastomoses with the palpebral arteries.

9. The Arteria Frontalis passes out of the orbit near the supra-orbitary foramen. It is quickly divided into branches, which go to the orbicularis, the occipito-frontalis and corrugator muscles, and to the frontal sinus.

Of the Veins of the Orbit.

The blood distributed to the eyeball and to its auxiliary parts has two routes for returning to the heart: one through the cavernous sinus, and the other by the superficial veins of the face. As a general rule, all the branches of the ophthalmic artery which reach the eyelids, or become otherwise superficial, return their blood by the latter route; and those whose distribution is to the ball of the eye and to the parts deeply seated in the orbit, return their blood by the sinus.

When the veins are well injected, a very considerable number is manifested in both eyelids. They form a handsome net-work, the meshes of which are small and numerous, and commence by small roots at the margin of the eyelids. The vessels of this net-work becoming, successively, larger from the centre to the circumference of the orbicularis muscle, cover the whole surface of the latter, and from the thinness of the skin are readily seen beneath it. The veins of the lower eyelid are discharged into the facial vein, where it borders on the orbicularis; and the veins of the upper lid, being bordered along the superior margin of the orbicularis by a horizontal branch of the temporal vein, discharge themselves into it.

The Ophthalmic Vein (*sinus ophthalmicus*) is the large trunk within the orbit which receives, successively, the remaining blood of the eye, and passing along the internal parts of the orbit, crosses over the optic

nerve, and penetrates through the optic foramen into the cavity of the cranium, where it terminates in the cavernous sinus. It may be considered as commencing by anastomoses with the facial vein at the internal canthus; it then receives the following branches:—

1. The nasal, which arises from the parts about the internal canthus of the eye.
2. The anterior ethmoidal, which comes from the nose and frontal sinus.
3. Branches from the recti and obliqui muscles.
4. The lachrymal vein, from the lachrymal gland and levator palpebræ muscle.
5. Posterior ethmoidal vein, from the nose.
6. The ciliary veins, or those of the choroid coat, which are very numerous.
7. The central vein of the retina, which is collected from three or four principal branches, and follows the course of the artery of the same name, through the cribriform part of the sclerotic coat, and through the centre of the optic nerve. The trunks of this vein anastomose, at the anterior margin of the retina, with those of the Ciliary Body.

There are, of course, frequent anastomoses between the veins of the eyelids and the primitive branches of the ophthalmic vein.

Of the Nerves of the Orbit.

In addition to the optic nerve, there are several belonging to the eye and to its auxiliary parts; they are derived from the Motor Oculi or third pair; from the Trochlearis or fourth pair; from the first branch of the Trigeminus, or fifth pair; and from the Motor Oculi Externus, or sixth pair. For an account of which, see Nerves.

SECT. II.—OF THE BALL OF THE EYE.

The Eyeball (*bulbus oculi*) is situated within the anterior half of the orbit, from which it is kept separated by its auxiliary parts, and by a large quantity of adipose matter which fills up their interstices. It is very nearly spherical, but not so much so as to prevent its antero-posterior diameter, which is about an inch long, from exceeding in measurement every other. Such, at least, is the general opinion of anatomists; but from experiments, made by distending the eye with mercury, I have been induced to doubt its correctness, and especially in the African; for, in the latter, I have uniformly found the transverse diameter to exceed the antero-posterior by a line or more. The Eyeball is also somewhat flattened at the insertion of each of the straight muscles.

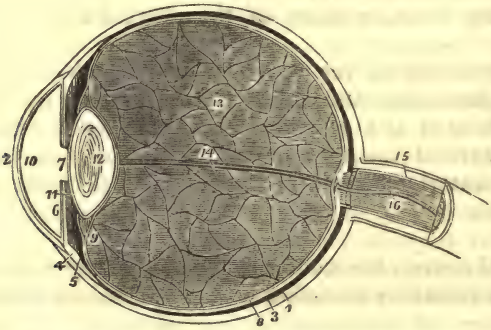
It is formed by a series of concentric tunics, one investing the other, and by humors contained within those tunics. Of the former, the Sclerotica and the Cornea are external; the Choroidea and the Iris next; and the Retina is internal. Of the Humors, the Vitreous is,

by far, the most abundant, and constitutes a principal part of the eyeball; the Crystalline Humor is in front of the vitreous; and the Aqueous is placed between the crystalline and the cornea.

Tunics, or Membranes of the Eyeball.

The Sclerotic Coat (*tunica sclerotica, albuginea*) forms about five-sixths of the exterior investment of the eyeball, the remaining sixth of which is obtained from the cornea. At its posterior part it is joined by the optic nerve: this junction does not occur precisely at its axis or

Fig. 289.



A longitudinal section of the Globe of the Eye.—1. The sclerotic coat. 2. The cornea. 3. The choroid coat. 4. The ciliary ligament. 5. The ciliary processes. 6. The iris. 7. The pupil. 8. The retina. 9. The canal of Petit, which encircles the lens. 10. The anterior chamber of the eye, containing the aqueous humor. 11. The posterior chamber. 12. The lens enclosed in its proper capsule. 13. The vitreous humor enclosed in the hyaloid membrane. 14. A tabular sheath of the hyaloid membrane. 15. The neurilemma of the optic nerve. 16. The arteria centralis retina.

centre, but at the inner side of it. When the optic nerve is detached at this junction, a small round hole is perceptible in the sclerotica, or, rather, it is more frequently perceived as a thin cribriform lamella, through the holes of which the pulpy part of the optic nerve passes, so as to get within the eye. This cribriform lamella, or the appearance of it, is no doubt produced artificially by the nerve being commonly cut through very near the eye; and, as Prof. Jacobs, of Dublin, very properly suggests, should be considered as the most anterior termination, or the point of the optic nerve instead of as a portion of the sclerotica. The neurileme of the optic nerve is so arranged, that small round longitudinal canals are left, which contain the nervous matter; from this cause it happens that a thin section of the optic nerve in any part of its course in the orbit, will, if held up to the light, manifest the same cribriform arrangement with the part alluded to. This part of the structure of the optic nerve will be readily understood by the American student, in comparing it with the pith of the Indian cornstalk, which, being traversed longitudinally, by many fibres, upon the drawing of them out, an equal number of longitudinal canals is left in their places.

At its fore part, the edge of the sclerotica is bevelled all around for its junction with the cornea; and though nearly circular, is not completely so, from its horizontal diameter being somewhat greater than any

other. There are several orifices of inconsiderable size scattered over the sclerotica, some of which are oblique and others direct: they transmit the blood-vessels and nerves. The Sclerotica is nearly a line in thickness at its back part, from which it gradually becomes reduced to half that thickness in front, where it is strengthened by the tendinous insertions of the recti muscles. Its internal surface is smooth and somewhat shining, being loosely attached to the cellular substance intervening between it and the choroid coat; but the external surface is rough, and more obviously fibrous, and is attached somewhat strongly to all the adjoining parts by the cellular substance called the sclerotic fascia (*Capsule of Tenon*).

The sclerotica is of a white color, and consists of a single layer, whose structure is essentially fibrous. The fibres are very closely compacted, and compose an intertexture which cannot be unravelled. It is so firmly united to the dura mater covering of the optic nerve, that many anatomists, notwithstanding its greater thickness, are disposed to speak of it as a continuation of the same. Its strength and its want of elasticity suit it remarkably to maintain the form of the eye, and to resist injuries. Out of the many blood-vessels that penetrate it, but few ramify in its structure. It is probable that some of the filaments of the ciliary nerves are left with it.

The tunica arachnoidea follows the course of the optic nerve, within its coat of dura mater, and forms, in the eye, just around the cribriform plate, or foramen of the sclerotica, a circular pad: it is then reflected on the internal face of the sclerotica, as far as its anterior edge. It is this which causes the internal face of the sclerotica to be smooth and shining, and thereby to correspond with that of the dura mater.[1] This circumstance is more readily proved in a very young eye than in the adult one.

The Cornea (*cornea*), as mentioned, fills up the aperture at the fore part of the sclerotica, and, of course, has the same diameters, with this opening; measuring thereby more transversely than in any other direction. It is a segment of a smaller sphere than the sclerotica, and is, consequently, more convex than it. Its thickness is uniform, and commonly exceeds that of the sclerotica at the fore part of the latter.

Its circumference adheres very closely to the sclerotica, and presents a bevelled or oblique edge, which is inserted into the corresponding bevel of the sclerotica, so that the latter includes the former. The bevel exists above and below; on the outer and the inner border the cornea is received into a groove of the sclerotica. The closeness of this junction induced the older anatomists to consider these membranes as one and the same, notwithstanding their obvious difference of sensible properties. Their adhesion yields to protracted maceration. The cornea is covered in front by a layer in continuation of the tunica conjunctiva, which unites the eyeball to the eyelids. This may be proved by dissection, by maceration, and by the layer coming off entirely, along with the epidermis of animals that are subject to this process of

[1] J. F. Meckel. Zinn supposed this surface to be derived from the pia mater.

moulting; as the locust, snakes, and others. On its posterior face the cornea is covered by the membrane of the aqueous humor (*membrana descemeti*); which may be rendered evident by steeping it in spirits of wine, whereby the latter membrane is made more hard, and may be thus torn off. This capsule of the aqueous humor differs decidedly from the cornea in not being made so opaque by the immersion in spirits of wine; we may hence infer the defect of an albuminous constituent in it.

The cornea in a natural state is perfectly transparent, and readily transmits the rays of light. It is of a fibrous structure, easily manifested by soaking it in alcohol, and consists of an indefinite number of laminæ, which are placed one against the other like the leaves of a book; they are united by a delicate transparent cellular substance which permits the laminæ to slide upon each other. These laminæ are kept moist and pellucid by an interstitial secretion of a fluid equally pellucid with themselves; the abundance of which in health gives to the eye its brilliancy, and the deficiency of it in illness and in death causes the eye to look dim and somewhat opaque. Its evaporation, which no doubt is continually occurring, is as constantly supplied by a fresh and abundant secretion. The motion of the eyelids sweeps the residuum, after the evaporation of its watery particles, from the surface of the cornea: without this process, the residuum appears as a thin layer or film of albuminous matter spread over the cornea, when the eye is kept open without winking for a considerable time. The cornea under the microscope has a close resemblance to cell-cartilage or fibro-cartilage, approximating, however, more the former, but the cells are not in the same abundance. They have around them an investment of bright fibres, loosely connected together, and forming a plexus resembling areolar or cellular tissue.

Fig. 290.

Horny Epidermis on Conjunctiva as it covers the Cornea.—*a*. Insulated scales. *b*. Tesselated simple lamina of scales, and lower down is seen a double lamina of the same.

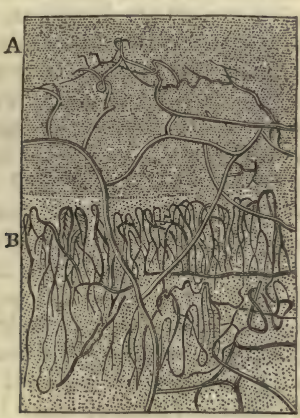
The cornea seems not at first sight to have the strong unyielding structure of the sclerotica, yet the application of mechanical force to the eyeball shows that it is stronger. Neither has it vessels, conveying red blood naturally, yet, in a state of inflammation, its capillaries dilate so as to admit red blood, and deposit coagulating lymph between its layers. It is common for anatomists to attribute a want of sensi-

bility to it in a natural state: as a general rule, this is fallacious; for many persons, where the eyes are not inflamed, suffer extremely from its being cut in cataract, and sometimes faint from the pain; while others are truly unconscious of the incisions made through it. For this opinion, I have had a full assurance from repeated observations on the practice of the late Dr. Physick, as well as from instances in my own hands.

The difference of actual texture between the cornea and the sclerotica is very inconsiderable; we are commonly misled by the transparency of the cornea, but, if the albumen in it be coagulated by alcohol or neutral salts, the filaments of the two are identical in appearance. Dr. Arnold considers both to be formed of cellular substance permeated by an extremely fine close set of lymphatics,[1] an idea originating with Mascagni and applied by him to every tissue of the body.

If a minute injection be successfully thrown into the conjunctival blood-vessels of an infant, a beautiful vascular corona is formed at the anterior margin of the sclerotica. Professor Roemer, of Vienna, considers it to consist of two layers, a superficial, derived from the lachrymal and palpebral, and a deeper one, from the muscular and ciliary arteries. From this corona the surface of the cornea is supplied, and

Fig. 291.



Blood-vessels of the Cornea.—A. Superficial vessels belonging to the conjunctival layers, and continued beyond the margin of the cornea. B. Vessels of the sclerotic running their course and returning at the margin of the cornea.

also its substance by converging branches. The superficial vessels are prolonged naturally one-eighth or half a line beyond the margin of the cornea and return as veins. The deep do not pass into the cornea, but end at its margin, in dilatations which return as veins. When blood-vessels are formed in the cornea beyond these limits, they are, as in the case of an apparently vascular cartilage, the attendant of a new tissue in the cornea, the product of inflammation.

The existence of nerves in the cornea is by no means evident. Some anatomist, as Schlemm, claim to have traced branches of the ciliary

[1] Lawrence on the Eye, p. 14.

nerves into it;[1] but this is denied by Arnold. Pappenheim is said to have followed nerves between the laminæ.

The Choroid Coat (*tunica choroidea vasculosa*) is placed immediately within the circumference of the sclerotica, and is of equal extent. At its posterior part it furnishes, for the passage of the optic nerve, a single circular opening, the margin of which is somewhat thickened, and perfectly distinct from the pia mater investment of the nerve, from which some anatomists have desired to trace this coat. The anterior opening of the choroid is bounded by the ciliary ligament and by the iris. On its outer side may be seen an abundance of loose flocculent cellular substance which joins it to the sclerotica. Internally, it is spread over the retina, but does not adhere to it.

The choroid coat is closely fastened, at its anterior margin, to the corresponding part of the sclerotica, by a ring which surrounds it, of a short compact cellular tissue. This ring, called the Ciliary Ligament, (*ligamentum ciliare*, *orbiculus ciliaris*,) is from a line to two lines in breadth, and may be readily distinguished by its whiteness, contrasted with the dark color of the choroid. It is intimately united to the latter, and seems to form a part of its structure, whereby it is caused to detach itself entirely from the sclerotica, and to adhere, by preference, to the choroid when these two membranes are separated.[2] The iris is set in the front margin of the ciliary ligament, so that the sclerotica and the cornea may be peeled from the choroidea and iris, without impairing the continuity of the two latter. Just beyond the junction of the two last, the ligament presents a small ridge or elevation all around, which is fitted into a corresponding fossa at the circumference of the posterior face of the cornea.

The internal face of the choroid coat, as well as its anterior margin, undergoes a very remarkable change from the general plan of this tunic, by forming what is called the Ciliary Body (*corpus ciliare*, *corona ciliaris*). In order to see this in the most favorable manner, the eye should be laid on the cornea, and its posterior half cut away. It will then be evident that, just behind the iris, and within the circumference of the ciliary ligament, the internal face of the choroid coat forms a considerable number of radiated folds or little ridges, which converge from behind forwards and inwards. These folds commence by striæ, almost imperceptible to the naked eye, which are in contact with the fore part of the vitreous humor, and with the canal of Petit; and thereby not only impress the neighboring portion of the tunica hyaloidea with their shape, but even leave upon it the black pigment with which they themselves are covered. These folds, when they get near the circumference of the iris, coalesce one with another, and terminate in a considerable number (from fifty to sixty, according to Sœmmering) of processes (*processus ciliares*), the central extremities of which are loose, and float in the aqueous humor. Some of

[2] Lawrence on the Eye, p. 21, London, 1841.

[2] Fontana asserted, from seeing it in an ox, that a circular canal was to be found in this ligament; many examiners have failed in finding it, and its existence is denied by Arnold, who states it to be a venous tube in the thickness of the sclerotica for receiving the veins of the Iris, and called by him Circulus Venosus Iridis. In man it is said to be in the substance of the cornea, under the name of Canalis Schlemmii. (Von Behrs, Anat. Phila. ed. i. 1847.) It cannot be injected except from the arteries.

these processes are longer than others. As a whole, the ciliary processes constitute a ring of converging filaments, which are a line or more in length, placed along side of, and in contact with, one another; the external periphery of the ring adheres to the ciliary ligament, and through it to the greater circumference of the iris, so that the ring appears, but fallaciously, to be continuous with the iris. In certain animals, as the sheep, the radiated appearance of the iris, on its posterior face, favors this notion still more. The internal periphery of the ring presents the central ends of the filaments detached from one another, and of a downy appearance. With the handle of a knife, they may be readily pushed backwards and forwards. Generally speaking, the ciliary processes are so much concealed by the iris that they cannot be seen in the living body through the cornea: in cases, however, of extreme dilatation of the pupil by narcotic applications, their central extremities are brought into view.

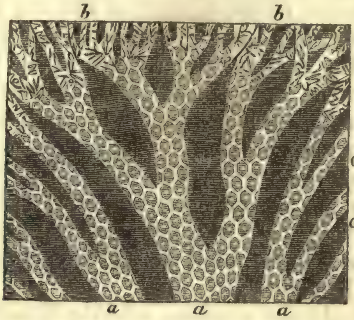
The choroid coat always appears, when uninjected, of a very dark brown, or black color, arising from a black paint (*pigmentum nigrum*) being very thickly spread over the whole of that surface of it which is adjacent to the retina, and being also diffused through its thickness. This paint is more abundant near the iris than posteriorly, being laid on there in flakes, in the intervals between the ciliary striæ, and tinging also the ciliary processes. It may be removed in a considerable degree, indeed almost entirely, by maceration, or by careful washing with a camel's hair pencil. This pigment of the choroid coat is contained in very fine cells, of a hexagonal shape, and making a continuous membrane from their abundance. Its particular color is of a most durable kind. According to the observations of Bichat, the long-continued action of light upon it, when this pigment is transferred from the choroid to a piece of paper, does not affect it; neither is it changed by being submitted to very strong chemical agents, as sulphuric, muriatic, or nitric acid, alcohol, or caustic potash. This degree of indestructibility of color is an invaluable property, and almost singular; for it is well known to the keepers of medicinal articles that the colors of them all yield to the continued influence of light, and that they also become weaker by the same cause. This indestructibility by light continues so long as the dry state is preserved. A human choroid kept in alcohol and exposed to light I have generally found to turn white in a series of years; in the sheep and bullock it is not so.

In regard to structure, the choroid coat is thin, soft, and easily lacerated: when cleared of its pigment by maceration, it is semi-transparent, and is then seen evidently to consist of but one lamina; unless we may be disposed to consider as a second one the pigment, naturally on its internal face. It has no appearance of fibres in its composition, but, when injected, seems to consist almost wholly of arteries and of veins.

The arteries are branches of the ophthalmic, and are called ciliary. There are two long Ciliary Arteries, which penetrate the sclerotic coat not far from the optic nerve, and pass, one of them, on the external and superior part of the choroidea, and the other on its inferior and nasal side, to the front of the eye. In this course they do not send off any branches of consequence till they reach the iris, upon

which they are distributed. The Short Ciliary Arteries are much more numerous than the others, and also smaller; their number sometimes

Fig. 292.



Section of Choroidea of the Ox, magnified fifty-six diameters. *a, a, a.* Veins covered by a single layer of pigment cells. At *b, b,* the pigment is pointed and reticulated. *c, c.* Intervals of veins thickly covered with the pigment cells. After Gerber.

amounts to twenty; the most of them penetrate the sclerotica from behind, near the optic nerve also.[1] They quickly divide into a great number of branches, which depart at very acute angles, and have frequent anastomoses with one another. These branches run forwards, nearly parallel, and at the fore part of the choroides form a very intricate intertexture, which is continued upon the ciliary processes, and communicates with the vessels of the iris.[2]

The veins of the choroid coat are also extremely abundant. They run from before backwards, and the branches which concur to form them, being adjacent with, and parallel to each other, for the most part, form large curves, the convexity of which is forwards; they, moreover, anastomose freely, and thereby produce a vascular sort of net-work, filling up the concavity of some of the curves. These veins, called the Vasa Vorticosa, are nearer the external surface of the choroides than the arteries, and are assembled into twelve or fourteen trunks, which, engaging in the sclerotica, near its middle, run for some distance in its substance, and then, by their junction, are reduced to four or five in number. The latter, disengaging themselves from the eye, join, subsequently, the ophthalmic vein.

In addition to the veins mentioned, the long ciliary arteries have their venæ comites, which take a course parallel to and adjoining them. These veins do not observe the vortical arrangement of the others: they bring back the blood of the iris, and terminate in the larger trunks of the others.

The choroidea has been most cautiously explored by the celebrated Sœmmering, whose observations have tended very much to determine the opinions of anatomists concerning many parts of the eye. A curious remark of his is that "the human eye may be distinguished from that of animals by a form of this vascular net-work, entirely peculiar; for example, in the eye of the ape, its vascular tissue differs not only from

[1] Sœmmering, Icones Oculi Humani. [2] Ibid.

that of the human subject, but also from that of the dog, and still more evidently from that of the calf. From which cause, it would be as

Fig. 293.

A view of the Choroid Coat with its vessels injected.—1. The optic nerve. 2. Posterior portion of the sclerotica, cut off circularly. 3, 4. The ciliary ligament. 5. The iris. 6. Ciliary nerves. 7. Long and short arteries of the choroid coat. 8. Long internal ciliary arteries of the choroid coat. 9, 10. Vasa vorticosa.

easy to distinguish with a microscope, the choroides, well injected, of different animals, even a piece of only the forty-eighth part of an inch in extent, as it is easy to distinguish a poplar stripped of its leaves from an oak, a pear tree, an apple tree, or any other tree, by the arrangement of its trunk and branches."

The choroides, on its internal face, is not smooth, but velvety, which becomes still more conspicuous when the eye is finely injected and examined with a microscope. Meckel considers the appearance to depend upon its very fine tissue of vessels. This surface is called Tapetum.[1] In the bullock, and some other animals, at a particular part, it presents a shining, silvery appearance, and may be torn off from the external surface. Ruysch attributed two laminæ to the choroid membrane in the human subject, the internal of which was called after his name, but the distinction is now generally abandoned.

The Iris (*Iris*) is a circular plane placed at the front of the choroides, and having, in its centre, a round opening called the pupil (*pupilla*). Its external circumference, as stated, is attached to the ciliary ligament, and by it to the choroid coat, and is exactly at the junction of the cornea with the sclerotica. Professor Sœmmering has bestowed much attention in ascertaining whether this membrane is perfectly flat or somewhat convex in front, and by repeated observations, carefully made, has assured himself that it is flat.[2] My own observations and preparations have induced me to believe that in many cases it will be found slightly convex in front, as Petit asserted more than a century ago. In a moderate state of dilatation, its nasal or internal border is somewhat narrower than its external or temporal. With the exception of its external circumference, every part of the iris is devoid of any attachment; by which arrangement it moves freely in the aqueous humor, so as to contract or dilate the pupil, according to the quantity of light admitted upon the eye.

[1] From tapes, tapestry.

[2] Icones Oculi Humani.

The iris, with the exception of its central or pupillary circumference, where it is thinner than elsewhere, is much thicker than the choroid

Fig. 294.

An anterior view of the Iris as attached to the Choroid Coat. 1. The choroid coat. 2, 3. The ciliary ligament. 4. The great circumference of the iris. 5. The anterior face of the iris. 6. Its lesser circumference. 7. The striated or ray-like appearance of the iris. 8. The pupil. 9. The ciliary nerves dividing as they penetrate the ciliary ligament. 10, 11. The ciliary blood-vessels.

coat. The posterior face of the iris, sometimes called *Uvea*, is covered in great abundance with pigmentum nigrum. When this is removed by maceration, which may be readily done, the membrane becomes semi-transparent. Its anterior surface is the seat of the color, which characterizes every individual's eyes. There are but two of these colors, light blue and orange, the predominance of one or the other of which, assisted by the dark ground on the back of the iris, gives the cast of hue to the eye. The front surface, when examined on the living eye, with the microscope, is seen to be downy or flocculent, and is traversed by filaments, forming an intertexture, some of which are circular, others oblique, and others radiated. This arrangement is remarkably distinct in the eye of the seal.

The power which the iris has of dilating the pupil when there is but little light, and of contracting it when there is much, has induced many anatomists to think that it is formed of muscular radiated fibres, which by their contraction produce the first motion, and of circular ones which produce the last. Among these anatomists may be mentioned, Ruysch, Morgagni, Zinn, Sabatier. Ruysch asserted that the radiated fibres extended from the greater circumference of the iris to the pupil, and were fixed there by very delicate tendons. The late Doctor Monro, of Edinburgh, has described particularly the circular fibres, and a preparation of the bullock's eye which belonged to him was exhibited there, where these fibres are found around the margin of the pupil. The several fibres can only be seen distinctly, when the pigmentum nigrum is washed away. Demours and Meckel deny the existence of the radiated fibres. The late distinguished Professor Wistar taught that the contraction of the pupil was produced by circular fibres, and the dilatation of it by its elasticity. In objection to this, the late Dr. Physick remarked, that as elasticity is as much a property of dead as of living matter, in death, therefore, we should always find the pupil dilated from the want of active contraction in the circular fibres; also, in cases of concussion of the brain, where there is a sudden loss of sensibility and of muscular motion, the pupil should be invariably dilated; but the fact is, that the pupil remains just in the same state that it was at the moment of the accident. The distinguished anatomist, Arnold, had, after very careful inquiry, come to the conclusion

that the Iris is formed of numerous blood-vessels, of many nerves and of cellular substance. The point of the muscularity of the Iris received a strong confirmation from the observations of Mr. Bauer in 1822,[1] and since then additional observations to the present date, with the most improved microscopes, have added to the evidence so that the affair may be considered as almost incontrovertibly settled. The most modern observers admit, as former ones did, two orders of fibres, the radiated and the circular; the first occupying principally the front of the iris and the last the posterior face. These muscular fibres are destitute of transverse striæ, form a plexus by their unions, and resemble the muscular fibres of the large intestines.[2]

Notwithstanding the extreme sensibility and mobility of the iris on the admission of light, one is occasionally astonished to find it not contracting when instruments are applied to it, as I have had an opportunity of twice observing, upon the removal of a considerable portion of it, in making an artificial pupil for opacity of the cornea. In these cases, upon the letting out of the aqueous humor, it became quite as flaccid as we are accustomed to see it in our dissections. The same remark has been made by the late Sir Charles Bell.

The Blood-Vessels of the Iris are principally branches of the Long Ciliary, which have been alluded to. Each of the two Long Ciliary Arteries, having gained the greater circumference of the iris, bifurcates; the bifurcation diverges along this circumference, and joins with the corresponding one of the other arterial trunk. From the circle thus formed there proceed radiated branches, that run towards the pupil, and form around its margin, by their frequent anastomoses, a fine vascular net-work. The radiated branches themselves give off collateral branches, which supply the intermediate spaces of the iris.[3] The veins of the iris are also numerous, but cannot be quite so distinctly seen; they enter into the long ciliary veins, and also into the vasa vorticosa.

The nerves of the Iris belong, in part, also to the choroid coat, and are classed under the term Ciliary (*nervi ciliares*). They arise from the ophthalmic ganglion, and from the trunks contributing thereto, and are about twenty in number. They penetrate the posterior part of the sclerotica obliquely, and then run forwards between it and the choroides. Having reached the posterior part of the ciliary ligament, they penetrate it, and distribute their filaments in its substance, after the same fashion that the trigeminus nerve is divided in its ganglion. This circumstance has given occasion to Sœmmering to consider the ligament as a true ganglion, and to call it Annulus Gangliformis. The nerves then get to the front of the iris, and are there distributed as white converging filaments; in the course of which may be observed small nodes, supposed by Meckel to be Ganglions.

The trunks of the ciliary nerves depart from the common form of such bodies, by being flattened instead of cylindrical: they are small, and resemble sewing threads. From their number, the iris is probably

[1] Philos. Trans.

[2] For the opinions of Pappenheim, Krause, Valentin, and others, in favor of this view, see Huschke, Traité de Splanch. p. 653, Paris, 1845.

[3] Sœmmering, Icones Oculi Humani.

more abundantly supplied with nerves than any other organ of the body.

Interposed between the choroides and the retina, is a most delicate serous membrane (the *tunica Jacobi*).[1] By preparing the retina in the usual way, and then floating the eye in a saucer of water, this membrane may be turned down with the handle of a scalpel from the optic nerve to the termination of the retina. It is supposed to be the seat of the ossifications which are sometimes met with in the eye. This membrane, considered by some as in fact the external lamina of the retina itself, is composed of corpuscles set in a perpendicular direction[2] like the pile of velvet. These corpuscles are of two sizes, great and small, of which the latter are more numerous than in the others.

The Retina (*retina*) forms the deeper coat of the eye, and lines the internal face of the choroides almost in its whole extent. The optic nerve, having passed through the sclerotica and choroidea, terminates on their inner side by a bulb or button-like end; from the circumference of which the retina begins to expand, and may be traced satisfactorily as far as the commencement of the ciliary plaits of the choroid coat; where it ceases by a straight edge, somewhat thickened. Just at the edge, the retina adheres to the vitreous humor, and is supposed, erroneously by some anatomists, as Bichat and Monro, to be continued on to the circumference of the lens. Repeated dissections, and the substantial testimony of Sœmmering,[3] have satisfied me that the retina, that is, the nervous layer, cannot be fairly traced beyond the greater circumference of the impressions made on the vitreous humor by the ciliary striæ of the Choroides. When the eye is slightly macerated, the retina always parts from the vitreous humor at this line; moreover, when its structure is still more slightly changed by freezing and then thawing, the retina manifests a decided preference to separate there, and, under the most careful dissection, it is very difficult to prevent it. In addition to these considerations, there is a well-marked change of color at the line mentioned: in front of this line, the surface is transparent when cleaned from the pigmentum nigrum; whereas, if it were retina, it should be the color of ground glass, as is usual in the dead body: also the veins of the retina never trespass beyond this line, but are seen to cruise along it.

Most anatomists teach that the retina is an expansion of the optic nerve. Bichat believed that the latter terminated at the bulb, and that the retina was another part of the structure, but still consisting of the same sort of nervous matter. The latter opinion is probably the more strictly correct, because there is more pulpy matter in a section of the retina than can be found in the same length of the optic nerve. Also if the retina were simply an expansion of the nerve without any addition of matter to it, it should, from its hollow globular shape, be thinner in the middle, where it is most expanded, than it is where the expansion first begins at the bulb of the optic nerve; but this is not the case.

[1] Discovered by Dr. Jacobs, Professor of Anatomy in Trinity College, Dublin.
[2] Huschke, p. 659.
[3] Icones Oculi Humani.

The retina does not adhere to the choroid coat, neither to the vitreous humor which it encloses, except at the line mentioned; when this line of attachment is broken, the retina quickly collapses.

The texture of the retina is extremely soft and pulpy; in the living state, it is probably nearly transparent, but this can only be conjectured from the readiness with which the vessels of the choroid coat can be seen in animals destitute of pigmentum nigrum. It is composed of two principal laminæ, of which the external is nervous; and the internal, or that next to the vitreous humor, is formed of a fine reticulated cellular membrane with blood-vessels running through it. The external lamina may be removed by a camel's hair pencil, or by slight putrefaction and washing, so as to leave the internal entire. The celebrated John Hunter succeeded, however, in separating the two laminæ fairly from each other, and preserving them, so as to show their difference.

Exactly in the axis of the eye, or at its centre, posteriorly, consequently about a line and a half from the outer side of the bulb of the optic nerve, Sœmmering[1] discovered a yellow spot (*macula flava*) of a line in diameter, with a small hole in its middle, made by a deficiency of nervous matter. From the optic nerve there goes, towards the foramen, a small fold of the retina, two and a half lines long, pointed at its internal end, and obtuse or bifurcated externally. Unless the eye be fresh, these features cannot be seen distinctly, for the evaporation of the aqueous humor causes a collapse or wrinkling of the retina, which obscures them. But, in a perfectly fresh eye, which is well managed, they may be seen both from before and behind. It was thought, for some time, that the yellow spot and the foramen were peculiar attributes of the human being: more extended and successful observation has corrected this mistake, by detecting them in several classes of animals.

In a careful examination of the eye of the negro Williams,[2] I found in three hours after the drop fell (the eye consequently being perfectly fresh), the retina, in both eyes, of the color of oiled white paper or ground glass: it was seen distinctly to terminate at the beginning of the ciliary plaits of the choroid. The spot of Sœmmering was seen, but it was of a sea green, oval, a line in length, the centre marked by an olive spot: no foramen was seen satisfactorily. The fold of the retina, running to the entrance of the optic nerve, was very distinct, as well as the button-like appearance of the nerve at this point.

The point where the central artery of the Retina enters is called the Macula Lutea. Michaelis asserts that around it the filaments of the retina are arranged in arches, of which one part meets in the macula lutea, the next in succession converge regularly towards a line stretching from the macula lutea.[3]

The nervous lamina of the retina, from the bulb of the latter, becomes flattened and resolves itself into primitive filaments of uniform size, without knots or swellings; they anastomose reciprocally so as to form a plexus like intertexture. These filaments unite with one another

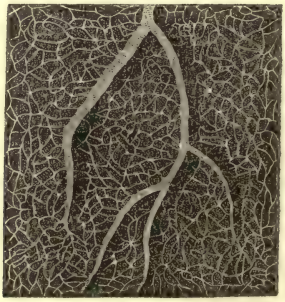
[1] Comment. Soc. Reg. Sc. Gottingen, 1779.
[2] Executed in the Moyamensing Prison, Aug. 9, 1839.
[3] Müller, Reports on Nervous System.

at very acute angles, and have scarcely an appreciable interstice between themselves, hence it is that the retina has the appearance of an uninterrupted membrane. These filaments are rated at the diameter of from $\frac{1}{1000}$th to the $\frac{1}{415}$th of a line, and are said to end in terminal loops like other nerves. Upon the inner face of the above layer, there is another formed of globules, and called by Krause the *stratum globosum;* it is composed of rounded hyaline vesicles with an excentric nucleus and nucleoli. By some it is admitted to exist on the exterior face of the nervous lamina and also in its thickness. Within this, again, is a granular layer, formed of yellow globules, and resembling the corpuscles of the blood; according to Valentin, they have a diameter of about the 1–238th of a line.

The nervous filaments of the retina are considered, by Treviranus, to depart, at certain points from their regular course, and to end in a papillary-like structure upon the internal face of the membrane. In all classes of vertebrated animals, this structure, if examined recently after death, has the appearance of a layer of cylinders, closely packed and placed with one extremity towards the centre of the eye: if undue time has elapsed since death, then the appearance is simply granular as described by Valentin.

The vascular layer of the Retina (*lamina vasculosa*) is formed by branches of the central artery and central vein, held in their places by cellular substance. The artery penetrates the nerve at the distance of half an inch or an inch behind the eyeball, and passing along the centre of the nerve, reaches the interior of the eye in the middle of the bulb of the optic nerve. From that point it divides into four or five branches, which pass forwards dividing into collateral branches, and finally form a very delicate arterial intertexture, whose filaments are distributed to the other coats of the retina, excepting the Tunica Jacobi. The veins undergo a similar arrangement, and, finally, collect into a central vein returning by the same route with the artery.

Fig. 295.



Capillaries in vascular layer of Retina, much magnified.—After Berres.

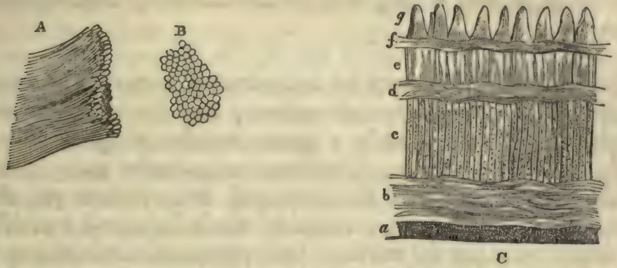
It is stated by Langenbeck, and some others, that the vessels of the retina are attended by filaments from the carotid ganglion, and from the ciliary nerves. The vessels of the retina have no communication generally with those of the choroid coat some anatomists[1] are, how-

[1] Henle—Tiedemann—Langenbeck, &c.

ever, of opinion that such anastomosis occurs at the bulb of the optic and at the anterior limit of the retina.

The yellow spot of Sœmmering, and the fold of the retina, are surrounded by a corona of the blood-vessels, and the opinion is entertained by Huschke and others that the foramen of Sœmmering is not an actual perforation, but a reduced thickness of the Retina, which corresponds with my own experience.

Fig. 296.



Structure of the Retina, after Treviranus.—A. Portion of retina of a sheep seen from the outer side, showing the cylindrical fibres, and at the right hand border some of the papillæ, in which the fibres terminate on the inner surface of the retina. B. Papillæ seen on the inner surface of the same retina. C. A thin perpendicular section of the retina of the hooded crow (corvus cornix), which had been hardened by maceration in spirits. *a*. Internal lamina of choroid. *b*. Layer of cellular tissue, in which the fibres of the retina radiate out. *c*. Perpendicular portion of the fibres of the retina. *d*. Second layer of cellular tissue, containing a net-work formed by branches of the arteria centralis retinæ, and giving a sheath of this vascular layer of retina to the nervous fibres. *e*. Larger nervous fibres which have acquired this sheath. *f*. Third cellular layer perforated by the papillæ *g*.[1]

The Papillæ of the retina are supposed to determine the facility of vision, and their diameter is estimated at about the $\frac{1}{8000}$th of an inch by Weber. Ehrenberg, after numerous experiments, came to the following conclusions: The smallest visible square of white upon a black ground, or the reverse, is about the $\frac{1}{405}$th of an inch. A shining metallic particle, as gold dust, can be seen of a diameter of the $\frac{1}{1125}$th of an inch. If objects be arranged in a close linear series, making for example a thread, and black, this thread may be seen of a diameter not less than the $\frac{1}{4900}$th of an inch, when held before a good light. It is a matter of common observation that an object invisible before being pointed out, afterwards becomes sufficiently visible by an act of attention to it.[2]

Humors of the Eyeball.

The Vitreous Humor (*humor vitreus, corpus vitreum*) occupies, with the exception of a very small part just behind the iris, the whole of the space posterior to the latter. It is, therefore, very nearly globular, is in contact the greater part of its extent with the retina, and at least as far as the latter membrane proceeds; in front, it is in contact with the crystalline humor, and from the margin of the retina

[1] Müller's Physiol. p. 1122.

[2] For many excellent observations on the Physiology of Vision, the reader is referred to Müller, loc. cit.

to the circumference of the lens it is in contact with the ciliary body, meaning thereby the ciliary striæ and processes of the choroides.

Two parts compose the vitreous humor,—the hyaloid membrane and a thin fluid. In a natural state they are perfectly transparent, and, therefore, cannot be readily distinguished from each other; but by immersion in spirits of wine the membranous portion is brought to the color of ground glass, and may then be studied very advantageously. The membrane, though extremely delicate, is generally strong enough to permit the whole vitreous body to be suspended in the air by a thread passed through it, and it may also be momentarily held up with a pair of forceps.[1]

The Tunica Hyaloidea may be traced as a complete capsule, forming the periphery of the vitreous humor; and from the internal face of this capsule there proceeds a great number of partitions dividing the whole cavity into cells of various magnitude and form. Some anatomists, who have frozen the eye, and then picked out the pieces of ice from the cells, have the notion of their being all cuneiform, and of their edges pointing forwards. Our preparations in the anatomical cabinet are perfectly satisfactory in exhibiting the existence of an arrangement of cells, but do not manifest a regular cuneiform shape in them.

When the capsule of the tunica hyaloidea has got to the distance of two lines, or thereabouts, from the circumference of the lens, it divides into two laminæ, which reunite at the circumference of the lens. They then divide again, and one goes before the capsule of the lens, and the other behind it. The space between the two layers, around the circumference of the lens, is the Canal of Petit, and is in that part of the tunica hyaloidea which is impressed by the ciliary striæ and ridges of the choroides. This impression is like the side of a flat ring with radiated lines crossing it, and constitutes the Zone of Zinn. At intervals, and passing from the exterior to the interior circumference of the canal, there is a sort of shortening or constriction of it, producing partial septa in its cavity; so that, when the canal is inflated, it seems to consist of a series of small cells, arranged circularly. The cells of the colon will give some idea of this arrangement, though they are produced in an entirely different manner.

The fluid part of the vitreous humor, by analysis, gives out 98.40 water, .16 albumen, and the remainder is saline. In consequence of the very small quantity of albumen in it, neither acids nor heat coagulate it to a striking degree.

The vitreous humor is supplied with a branch from the central artery of the retina. This branch does not convey red blood, but only serum, except in the fœtal eye. It may be injected, at almost any age, with size, colored with vermilion; but is then, of course, put very much on the stretch. It has been well described by Zinn. It penetrates the

[1] In Williams the criminal, executed here, as stated before, I found on the front of one hyaloid, at the side of the lens, an opacity of three by six lines, resembling an opacity of the cornea; it was just where the tunica hyaloidea is in contact with the ciliary plaits of the choroid, and was at first mistaken for a metal-like surface of the latter, as the tapetum of the lower animals.

vitreous humor near the optic nerve, and is disseminated by very fine branches on the periphery, and on the internal cellular structure of the tunica hyaloidea. M. J. Cloquet has described particularly one branch, which, running through the centre of the vitreous humor, in an appropriate canal, is spent by small ramifications upon the posterior part of the capsule of the lens.

Some anatomists[1] speak of a fluid between the tunica hyaloidea and the retina: when it does exist, it in all probability is the fluid of the vitreous humor, which has passed through the tunica hyaloidea after death.

The Lens (*lens crystallina*), or the Crystalline Humor, as it is very generally called, is placed immediately behind the pupil, in a depression on the front of the vitreous humor. Its shape is that of a double convex lens, of which the posterior convexity is greatest, being the section of a sphere whose diameter is from four to five lines, while the anterior convexity is in the proportion of a sphere of from six to nine lines. It, however, varies its shape in a remarkable degree at the different periods of life; immediately after birth, it is spheroidal; in about six years afterwards its lenticular shape is well marked, and, subsequently, it becomes more flat and thin. The usual breadth of the lens is about three and a-half lines.

The lens naturally is perfectly transparent. In the greater part of its thickness it has the consistence of half dissolved glue, but its centre is much more solid; this change is effected gradually from the circumference to the centre. When it is subjected to the mineral acids, to heat, to alcohol, and several other agents, it becomes much more solid throughout; it may then be separated, like an onion, into a series of concentric lamellæ, subdivisible into longitudinal fibres. Besides these, there are fibres more or less oblique which hold the lamellæ together. These arrangements prevail from the centre to the circumference of the lens; and between the laminæ there is a diaphanous humor resembling that between it and its capsule.[2]

The lens has a natural but adhering division into three equal parts, perfectly alike in shape, like an apple which one may have divided in that way. The filaments of which the laminæ are composed, run from before backwards, and have their ends directed towards the limits or lines marking out the primary division into three parts. Sir David Brewster has shown, by the action of polarized light, that those filaments are undulated or dentated at their edges, by which means they adhere. This is most distinct in fishes. The fibres of the lens are considered by Schwann to be originally formed from a series of cells, which are elongated and joined together.

Albumen enters very largely into the composition of the lens, which is readily proved by the thorough opacity following its immersion in spirits of wine. It is considered by some to approach the structure of cartilage more than any other tissue, also in its mode of nutrition.

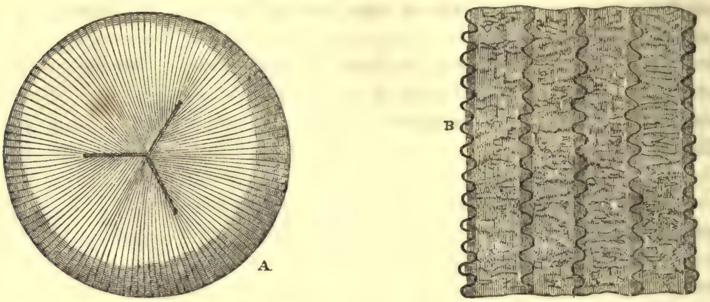
The lens is invested by a capsule which is a complete sac, having exactly its shape, but separated from it, to a very inconsiderable ex-

[1] Bichat, Anat. Descrip.

[2] J. F. Meckel.

tent, by the transparent humor alluded to, and called the Liquor Morgagni. The liquor Morgagni is composed of nucleated vesicles, of

Fig. 297.



A represents the triple division of the Lens, and the course of its fibres; B the tooth-like or serrated margins of the fibres of the lens.—After Brewster.[1]

the diameter of $\frac{1}{152}$d of a line, and connected by a transparent liquid,[2] and is more abundant in front than behind the lens. It is in several superimposed layers, and is considered by Valentin as the formative agent for the lens, the lens being formed at its expense, as the analogy of texture explains. The microscopical anatomists have seen in the vesicular conformation of both a resemblance to cuticle. The capsule is covered in front by a layer of the tunica hyaloidea adhering very closely to it, but which, in one instance, I was enabled to peel off partially in the eye of a sheep, from one side to the other. The capsule is covered in like manner on its posterior face by the tunica hyaloidea; but the two may be separated there more easily, according to the observations of Bichat. Some of the most distinguished continental anatomists are decidedly in favor of the capsule of the crystalline being a complete bag; but it is rather unsettled whether the exterior margin of the capsule bounds the lesser circumference of the Canal of Petit, or whether the two layers of the tunica hyaloidea unite previously at the circumference of the capsule. The latter seems to be the opinion of M. J. Cloquet. The late Dr. Physick, in some cases of membranous cataract, succeeded in drawing out the capsule entire, so as to exhibit its whole extent when floated in water.

The capsule in front of the lens is much thicker than the tunica hyaloidea, and its difference of character from the latter appears to me to be very strongly marked; for, notwithstanding its immersion in spirits of wine, it retains its transparency. It is hard and elastic, and when clipped with fine scissors, gives nearly the same sensation as the thin paring of a finger nail would; or, as has been observed by Haller, it in this respect resembles the cornea. The analogy with the cornea ceases, however, at this point; for the cornea has always so much albuminous matter in it as to be rendered turbid when it is immersed in alcohol. The posterior half of the capsule of the lens is not so well marked, either by its thickness or specific characters, as the anterior, yet

[1] Phil. Trans. 1833 and 1836.

[2] Huschke, Traité de Splanch. p. 699.

our preparations in the University demonstrate its existence equally as conclusively. It is more assimilated to the nature of the tunica hyaloidea.

In the injected fœtal eye, the artery of the tunica hyaloidea, which comes from the central one of the retina, is seen to furnish several minute ramifications to the posterior face of the lenticular capsule; some of its branches also go to the front of the capsule, but the latter part is furnished principally by arterioles from the ciliary body of the choroides. The two sets of arteries anastomose with each other; some of the latter are also spent upon the membrana pupillaris.

The point is doubtful whether any of these arteries penetrate into the body itself of the crystalline humor. Ruysch, Albinus, and Haller assert the fact of their having seen and injected them in the human species and in animals, and J. F. Meckel admits their testimony. Yet there are not many anatomists who can corroborate it by their personal observations. It should be observed that, if this vascular connection do exist, it is a very weak one; for the lens seems to be simply surrounded by its capsule without adhering to it.

Some veins which discharge into the veins of the choroid coat have been observed by Walther[1] on the posterior part of the capsule. It should be continually borne in mind that neither the arteries nor veins of the healthy crystalline, nor of its capsule, convey red blood; in which respect they correspond with the hyaloidea: for, if this were the case, vision would be very much disordered by it. It may be that the moats or specks seen in ophthalmia arise from the grosser particles of the blood getting into these serous vessels by the dilatation of the latter.

The Lens and its Capsule are devoid of nerves, at least none have been as yet traced into them.

The Aqueous Humor (*humor aquosus*) occupies the space which is between the anterior face of the crystalline capsule and the posterior face of the cornea. This space is unequally divided by the iris into two chambers (*cameræ*), of which the anterior is in front of the latter membrane, and the posterior behind it. In consequence of the convexity of the lens, the posterior chamber has but very little depth just behind the pupil; but its space is augmented at the circumference of the crystalline, so as to leave room for the floating of the ciliary processes and for the motions of the iris. The posterior chamber is, therefore, a circular or annular vacuity; the centre of which, from the projection of the centre of the crystalline, has scarcely any appreciable depth. The anterior chamber, in its shape, resembles the segment of a sphere: its depth depends essentially on the size and the projection of the cornea.

The aqueous humor is perfectly transparent, and almost as fluid as water. The analysis of Berzelius exhibits 98 parts of water, $\frac{1}{100}$th of hydrochlorate and lactate of lime, $\frac{1}{75}$th of some animal matter soluble in water, and a very small quantity of albumen. From the latter circumstance it will be understood how this fluid resists coagulation on

[1] De Oculis, Berlin, 1778.

the addition of alcohol or of mineral acids to it, and is only rendered in a very slight degree turbid by them. The rapidity of the exhalation of this fluid is remarkable; when the whole of it is lost in the operation for cataract, it is regenerated in from twenty-four to thirty-six hours. Its source has been sought for in suppositive canals and glands, but the more probable opinion is that it may come from any or all of the exhalant arteries of the chambers of the eye.

Like the other two humors of the Eye, the aqueous is furnished with a capsule, but whether it is complete or not is yet undetermined. By immersing the eye in hot water, or in alcohol, this capsule may be readily detected on the posterior face of the cornea, and to the greater circumference of the iris; it may even be traced for some distance on the front surface of the latter. Some of the French anatomists, as Demours,[1] Descemet, and J. Cloquet, have asserted that it continued also through the pupil to line the posterior chamber. An opinion like this, from the extreme tenuity of the part, must be rather the result of conjecture than of accurate observation: it has, therefore, never found its way with full force into the writings of anatomists. The loose condition of the pigmentum nigrum on the posterior face of the iris, and on the ciliary processes, would seem to be an objection to the existence of this capsule in the posterior chamber of the eye. But, if it really does exist there, as is pretended by M. Portal, who supposes it to be derived from the tunica hyaloidea, its structure is incomparably more delicate than on the cornea, and indeed is merely gelatinous.

Membrana Pupillaris.—The chambers of the Eye, till the seventh month of fœtal existence, and sometimes later, are perfectly separated from each other by the Membrana Pupillaris, called so from its position in the pupil of the iris. It was discovered in 1740 by Wachendorf, and is sometimes called after his name. It is a thin, delicate, and transparent membrane, which is stretched across the pupil from its circular margin, and may, by its color, be readily distinguished from the iris, when it has been made somewhat turbid by alcohol.

The Membrana Pupillaris consists, according to M. J. Cloquet,[2] of two laminæ placed back to back, of which the foremost is a continuation of the membrane which lines the anterior chamber of the eye, and the hindmost of that which lines the posterior chamber. According to this, it may be noted that each chamber has its distinct capsule. This membrane is very vascular; some of its arteries are those which subsequently form the internal arterial circle of the iris, and they radiate from the circumference to the centre of the membrane; others come directly from the long ciliary arteries, and others again from the arteries of the crystalline capsule. These several vessels are found principally on its posterior face. Its veins have not been observed.

This membrane first shows itself about the third month of fœtal existence, and is most perfect at the seventh; from the latter period it begins to decline, by disappearing from the centre to the circumference.

[1] Lettre, 1767.
[2] Journal Universelle des Sc. Méd. Paris, 1818. Mém. sur la Memb. Pupill. Paris, 1818.

At the ninth month it consists only in a few loose floccular shreds adhering to the pupil. M. J. Cloquet has ascertained that its vessels do not participate in its destruction, but that the arches which they form are retracted to the margin of the pupil, and there form the lesser or internal arterial circle of the iris. From the observations of Drs. Jacob and Tiedemann, it appears that traces of the membrana pupillaris exist for ten or fifteen days after birth. The latter, in one case, injected its vessels in a fœtus at full term.[1]

CHAPTER III.

OF THE EAR.

The ear, the organ of hearing, is placed principally within the petrous portion of the temporal bone, and consists in the External Ear or Auricle, the Tympanum, and the Labyrinth.

SECT. I.—OF THE EXTERNAL EAR.

The position of this portion of the organ is familiar to every one. It is useful in collecting the rays of sound, and in conveying them to the more internal parts. It is formed by the structure, exterior to the

Fig. 298.

Left External Ear.—1, 2. The beginning and termination of the helix. 3. Anti-helix. 4. Anti-tragus. 5. Tragus. 6. Lobus. 7. Scapha. 8. Concha. 9. Meatus auditorius externus.

petrous bone, called, in common language, the Ear; and by a bony canal which leads internally to the tympanum. The basis of the first portion is fibro-cartilaginous, on which circumstance it depends for the permanency of its shape.

[1] Amer. Med. Journ. vol. i. p. 192.

The ear, of common language, is divided into two parts, Pinna[1] and Lobus: the former is the most extensive, as it comprehends all the fibro-cartilaginous portion; the latter is attached to the inferior margin of the former, and, having no cartilage in its composition, is soft and pendulous.

In the centre of the external ear is a deep depression called the Concha; in the bottom of it is the orifice of the canal leading to the tympanum, and called Meatus Auditorius Externus. The circumference of the pinna is convoluted into a scroll called the Helix, which commences just above the meatus by a ridge. This ridge divides the concha into two unequal cavities, of which the lower is the larger. The scroll becomes gradually less prominent, till it terminates at the posterior inferior part of the pinna, in the lobus.

The Antihelix is the slightly curved and vertical eminence in the middle of the pinna: its lower part forms the posterior boundary of the concha, and its upper part bifurcates into two small ridges, between which there is a depression called the Scapha. Between the antihelix and the posterior half of the helix, is an oblong depression called the Fossa Innominata.

The Tragus is an elevation of the pinna placed in front of the concha, and inclining somewhat over it; opposite to it, at the inferior part of the concha, is the Antitragus.

The fibro-cartilaginous plate, upon which the external ear depends for its shape, is of a thickness very nearly uniform; of course, the ridges and depressions on its exterior surface have corresponding depressions and ridges on the side next to the head. It is interrupted at several places by fissures; for example, there is one of considerable size (*incisura major*) filled up with ligamentous matter, which separates the upper margin of the tragus from the beginning of the helix: there is another between the lower extremity of the antihelix and the antitragus. In the tragus, there are two, and sometimes three, small narrow ones (*incisuræ minores*), said, by Santorini, to be filled with muscular fibres; but the latter assertion does not correspond with the observations of subsequent anatomists, as the matter appears fibrous.

The external ear is united to the side of the head by three ligaments. The anterior arises from the root of the zygomatic process above the articulation of the lower jaw, and is inserted into the pointed production of cartilage on the fore part of the helix. The posterior arises from the swell of the temporal bone, which runs into the front margin of the base of the mastoid process, and is inserted into the convex side of the concha, at the beginning of the meatus auditorius. The superior arises from the temporal aponeurosis, and is inserted into the upper part of the concha. These ligaments lie immediately below the muscles destined to move the ear, and are a condensed lamina of cellular substance, rather than distinct ligaments.

The Meatus Auditorius Externus is, in the adult, an inch in length, reckoning from its external orifice to the membrane of the tympanum,

[1] From some resemblance to a certain shell-fish.

which closes it inwardly. It is about three lines in diameter, is rather oval than cylindrical, and somewhat smaller in the middle than at either of its extremities. It runs inwards, with a slight inclination forwards; the exterior half is formed by the cartilage of the pinna, and the internal half by the temporal bone; it departs from the horizontal course, in being curved at its middle where the two sections join. This curvature has its convexity upwards, so that when we wish to look to the bottom of the canal, the external ear must be pulled upwards and backwards.

The external half or portion of the meatus auditorius is formed by a triangular piece springing from the base of the tragus and from the inferior anterior part of the concha. This portion is nearly a tube, but is interrupted above and behind by the intervention of a dense fibrous tissue, continuous with, and indeed the same with that which unites the helix and the tragus in the incisura major. The internal margin of the cartilaginous meatus forms a point below, and adheres closely by ligament to the asperities on the margin of the bony meatus. If there were no fissures in the external ear, it would be almost immovable.

The skin covering the external ear is more delicate than in most other parts of the surface of the body. Its sebaceous glands or follicles are very abundant, and in infants secrete freely their peculiar fluid. When a slight inflammation occurs, this discharge is frequently purulent without erosion.

The lobe of the ear (*lobus*) is constituted by a duplication of skin, containing a delicate granulated adeps with some fibrous matter.

The skin, after lining the concha, descends into the meatus auditorius, and lines it also as well as the external face of the membrane of the tympanum. It adheres moderately to the cartilaginous part of the tube, and more tenaciously to its fibrous portions: between it and the latter are found many small reddish bodies, generally oval, the Glandulæ Ceruminosæ,[1] from which proceeds the earwax.[2] The skin is extremely thin in the bony meatus, adheres closely to its periosteum, and is highly sensible. Where it forms the exterior layer of the membrane of the tympanum, it may be detached from the latter with the slightest force, and seems to be converted almost entirely into cuticle. A slight maceration or incipient putrefaction frequently enables one to draw the cuticle out entire from the meatus, so that it looks in shape like the finger of a small glove.

The dermoid lining of the meatus, at its external orifice, is studded with fine hairs, which serve to keep out small bodies that may be floating in the air. A considerable number of small pores are also seen in it, which are the orifices of the ducts of the ceruminous glands. The discharge of the latter, when first secreted, is thin and white: by evaporation, it becomes thick and yellow, and by accumu-

[1] Duverney, Œuvres Anatomiques.

[2] They are placed, according to Buchanan, for the major part, in the middle and superior face of the meatus, and their number he estimates at from one to two thousand. Physiolog. Illustrations, 1825.

lating obstructs the passage. In this state it is much mixed with the moulting of cuticular scales.

There are several small muscles situated on the external ear, which are for the most part so feebly developed that they cannot always be found, and when they do exist they seem more like the rudiments of what is well marked in animals, than intended for a special purpose in the human body.

1. The Helicis Major is an oblong fasciculus, situated on the front of the helix. By its lower end it is attached to the point of cartilage on the front of the helix, and its other extremity extends to the top of the latter.

2. The Helicis Minor is a small square fasciculus, also on the front of the helix, between the folded margin of the latter and the inferior half of the helicis major.

3. The Tragicus is a square transverse fasciculus, on the front surface of the tragus, near its margin: its upper extremity sometimes runs into the helicis major.

4. The Anti-tragicus is a small oblong fasciculus, which arises from the upper extremity of the anti-tragus, and going upwards it is inserted into the inferior extremity of the antihelix.

5. The Transversus Auriculæ is on the internal surface of the pinna. It arises from the prominence of the concha, and is inserted into the hollow dorsum of the anti-helix.

6. The Dilatator Conchæ, or Musculus Incisuræ Majoris, of Santorini, is a small narrow band, and extends from the front of the helix across the great fissure, outwards and downwards to the tragus. It dilates the concha.

There are some other muscles which may be uniformly found, and are intended to move the external ear upon the side of the head, though from the want of exercise there are very few individuals capable of making them contract. They are as follows:—

1. The Attollens or Superior Auriculæ is placed on the side of the head beneath the integuments; it is a broad, thin, and somewhat triangular muscle, which arises from the inferior margin of the tendon of the occipito-frontalis, and from the temporal aponeurosis. It becomes narrower in its descent, and is inserted, tendinous, into the upper end of the pinna, by the elevation corresponding with the scapha.
Its name implies its action to be that of raising the pinna.

2. The Retrahens, or Posterior Auriculæ, consists in two or three oblong fasciculi, placed parallel, and one above the other. It arises from the mastoid portion of the temporal bone, above the mastoid pro-

cess, and is inserted tendinous into the convex side of the concha near the meatus auditorius.

It draws the pinna backwards.

3. The Anterior or Attrahens Auriculæ is a small quadrangular slip just above the root of the zygomatic process. It arises from the temporal fascia, and is inserted tendinous into the fore part of the helix just above its beginning.

It draws the pinna forwards and upwards.

SECT. II.—OF THE TYMPANUM.

The Tympanum is a cavity making the middle portion of the organ of hearing, being interposed between the meatus auditorius and the labyrinth. Its depth is about three lines; its antero-posterior diameter about six and its vertical diameter rather more, though from the general inequality of the cavity, and its communication with adjoining cavities, it is not easy to fix upon very precise measurements. It is bounded externally by the membrane of the tympanum.

The Membrane of the Tympanum (*membrana tympani*) is a complete septum, interposed between the meatus externus and the tympanum. It is placed very obliquely, so that its upper edge inclines outwards, and its under edge inwards; the latter, therefore, forms a very acute entering angle with the inferior part or floor of the meatus, and gives to that portion of the meatus an additional length which renders it difficult to see to its bottom. The membrane of the tympanum is nearly circular, and has its circumference adhering very closely to the external orifice of the tympanum. It is slightly tense, and has its middle drawn inwards by being attached to the handle of the malleus.

The membrana tympani consists of four laminæ; the two exterior of which, being the cuticle and the cutis vera, which line the meatus auditorius, seem to be in common, are easily detached by maceration, as mentioned before, and seem scarcely to adhere to the layer below. The cuticle itself is well developed; the cutis vera has scarcely an existence, being indicated by some trivial change in texture, which is not recognized by many anatomists. The real case is that the cutis vera becomes very indistinct after we reach the orifice of the bony meatus, the cuticle there seeming to adhere directly to the periosteum of the part and then to pass so as to cover externally the membrana tympani. The third layer is the proper membrane, and is distinguished by its dryness and by its transparency. Sir Everard Home was enabled to detect radiated muscular fibres, forming it in the elephant.[1] In the human subject, its fibrous character is best seen on its internal face, but the radiated arrangement is not so distinct. Caldani says it is formed by filaments, decussating each other at right angles, and intermixed with blood-vessels.[2] The internal layer is a continuation of the

[1] Philosophical Transactions, for 1800, London.
[2] Plate xcviii. Anat.

lining membrane of the tympanum; it is separated with some difficulty, owing to its tenuity.

The proper membrane of the tympanum, when successfully injected, exhibits a high degree of vascularity;[1] though, in its natural state, but very few red blood-vessels are seen in it. It is considered by some as representing the cutis vera, which is the more natural view. In such case the membrana tympani is limited to three layers instead of four.

The floor of the tympanum, or the side next to the labyrinth, presents an unequal surface. In its middle is a well-marked rising, the Promontory (*promontorium*), formed by one end of the labyrinth. Just above the superior margin of this prominence, near its centre, is an oval opening, called, from its shape, Foramen Ovale, or Fenestra Ovalis; having its long diameter horizontal, its superior margin rounded or concave, and its inferior straight. At the posterior inferior part of the promontory is another opening, which, though somewhat triangular, is called the Foramen Rotundum, or Fenestra Rotunda, and in the dried bone leads to the cochlea, but is naturally stopped by the lining membrane of the tympanum. According to M. Ribes, this membranous plug has also two other layers, an internal one, the continuation of what lines the cochlea, and a middle one, which is peculiar. In these respects there is a correspondence with the membrana tympani.

The Eminentia Pyramidalis is a small conical eminence projecting from the posterior part of the tympanum, on a line with the fenestra ovalis. It is hollow, contains a muscle, and communicates at the other end with the Canal of Fallopius. Lower down, and more externally, there is a small orifice (*apertura chordæ*), through which the nerve called Chorda Tympani passes.

The Mastoid Portion of the Temporal bone, in the adult, abounds in large cells or sinuses, which communicate freely with one another. They are distinct from the diploic structure of the bone, as they contain no medulla, and are lined by a continuation of the internal membrane of the tympanum, which is extremely thin upon them. The orifice of communication between these cells and the tympanum is placed at the superior posterior part of the latter: it is rough and irregular, and partially occupied by the short leg of the incus. Just in front of this opening, the cavity of the tympanum is extended vertically, for the purpose of accommodating the body of the malleus and of the incus, whereby they are in a great degree concealed, unless the corresponding margin of the tympanum be cut away.

At the fore part of the tympanum is the Eustachian Tube, which runs for six or eight lines in the substance of the petrous bone, near its exterior margin, and then terminates in a cartilaginous and membranous portion, which communicates with the pharynx at the posterior naris. The latter extremity of the Eustachian Tube is placed on a line with the posterior end of the inferior spongy bone. Its orifice is

[1] Ruyschii, Epist. Anat. Probl. viii. Also Anatomical Museum, Univ. Penns.

rounded or oval, is large enough to admit the tip of the little finger, and reposes against the side of the internal pterygoid process of the sphenoid bone. Though almost within the precincts of the posterior naris, this orifice is to be considered as opening into the pharynx.

This canal, in its whole length, measures nearly two inches, and, with the exception of the portion in the petrous bone, is cartilaginous and membranous. The cartilage is a single, thick, triangular plate, flat, and adhering by one of its edges to the internal pterygoid process. The under part of the tube is membranous, thin, and affords attachment to some of the muscles of the soft palate. Its course is nearly horizontal, backward and outward.

It is lined in its whole extent, by a very fine mucous membrane continuous with that of the pharynx and of the tympanum. This membrane is thickened at its anterior extremity by the mucous glands beneath it, which assist in giving the marked elevation to its orifice. The canal diminishes as it goes backward, so as to receive with difficulty a small probe.

By removing carefully the mucous membrane of the pharynx at and below the origin of the Eustachian tube, there will be found a fasciculus of muscular fibres, a line or two wide, sometimes less. This fasciculus arises from the upper part of the Palato-Pharyngeus Muscle, and crossing over the external face of the Levator Palati, goes to be inserted into the orifice of the Eustachian tube; one division of it reaching the tip of the cartilaginous portion, and the other the edge of the membranous part.

When this fasciculus contracts, it dilates the orifice of the Eustachian tube.[1]

Parallel with the bony part of this canal, but above it, and separated by a very thin partition of bone, is another canal which lodges a muscle of the malleus. On the outer side of the Eustachian tube is the glenoid foramen, by which, in the dried bone, the tympanum communicates with the glenoid cavity; in the recent state, the foramen receives the long process of the malleus and its muscle, and transmits the chorda tympani.

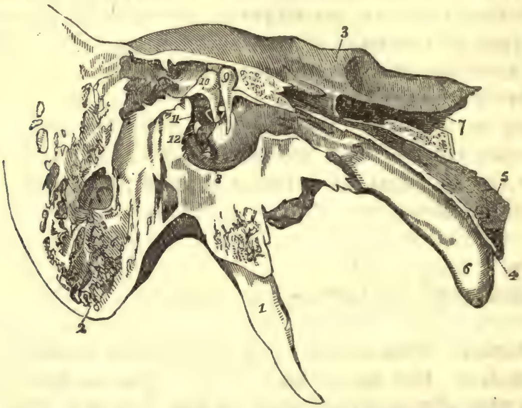
There are four bones in the tympanum, which, being successively articulated with each other, form a chain, one end of which is fastened to the membrana tympani, and the other end rests upon the foramen ovale. They are the Malleus; the Incus; the Orbiculare; and the Stapes.

The *Malleus* forms the fore part of the chain, and is placed almost vertically. Its superior extremity is the head, which is rounded, with the exception of the posterior face, where a small concavo-convex surface is observable, for its articulation with the incus. Its lower extremity is long and tapering, inclines inwardly, terminates by a little knob, and forms an angle with the part above; this portion is the ma-

[1] See Palato-Pharyngeus.

nubrium, and adheres its whole length to the membrana tympani, commencing at the superior margin of the latter, and insinuating itself between the internal and the proper layer, as far as the centre of the membrane. It is this adhesion, with the inclination inwards of the manubrium, that causes the membrane to be depressed in its centre.

Fig. 299.



A view of the inner wall of the Tympanum and Eustachian Tube in the recent state, with the small bones in their natural position. (Arnold.)—1. Styloid process of the temporal bone. 2. Mastoid process. 3. Fore part of the pars petrosa. 4. Pharyngeal orifice of the Eustachian tube. 5. Its cartilaginous part. 6. Its mucous surface. 7. Carotid canal. 8. Fenestra rotunda. 9. Malleus. 10. Incus. 11. Stapes. 12. Pyramid and stapedius.

Between the head and the manubrium is a short portion called the neck. From the superior external extremity of the manubrium there proceeds outwardly the short process (*processus brevis*); and from the front of the neck, there proceeds the long and very delicate process (*processus longus* or *gracilis*); concave externally and convex internally, which is insinuated into the glenoid foramen.

The *Incus* is behind the malleus, and is also upright. It consists in a body and two branches, which diverge very considerably, and has a general resemblance to a molar tooth with two roots, one of which has been broken. The body presents, on its fore part, a deep concavity, which articulates with the convex head of the malleus. The branch which arises from the back part of the body is horizontal, looks into the orifice of the mastoid cells, and is much shorter than the other. The inferior branch is long, upright, tapering, and nearly parallel with the manubrium of the malleus, but somewhat within it.

The *Orbiculare* is a very small flattened sphere of bone, which articulates with the lower end of the long process of the incus, and in adult life is most generally fused into it, so as to lose its distinctive character: the latter change sometimes occurs even in early infancy.

The *Stapes* is the last of the chain. It resembles very strongly the common stirrup iron, from whence its name, and is placed horizontally at right angles to the incus, being separated from the extremity of the

long process of the latter by the os orbiculare, and being directed inwards to the foramen ovale. It is composed of a head, two crura, and a base.

The head is oblong and flattened: it has a slight depression where it joins the orbiculare. The crura are slightly curved, with the concavities towards each other: the anterior is somewhat straighter than the posterior, and is also shorter. They are both excavated longitudinally, on their concave surfaces, and between them is stretched a process of the lining membrane of the tympanum. The base is precisely adapted to the fenestra ovalis, and is connected to it by the lining membrane of the tympanum, but not so closely as to prevent it from executing slight vibratory movements.

Between the malleus and the incus there is a movable articulation with the synovial membrane, but the other joints of the chain are simply ligamentous.

This chain of bones is moved by several muscles, which influence the degree of tension of the membrana tympani.

1. The Tensor Tympani is placed in the canal just above the Eustachian tube. It arises from the posterior extremity of the cartilaginous portion of the latter, and, having got into the tympanum, is changed into a small tendon, which, going outwardly, is inserted into the neck of the malleus, just below its processus gracilis.

It draws the malleus inwardly; consequently makes tense the membrana tympani, and drives the stapes into the fenestra ovalis.

2. The Laxator Tympani arises from the posterior end of the spinous process of the sphenoid bone, and passing behind the articulation of the lower jaw, into the glenoid foramen, is inserted, tendinous, along the processus gracilis of the malleus.

It draws the malleus forwards and outwards, so as to relax the membrana tympani.

3. The Stapedius arises from the bottom of the cavity in the pyramid, and terminates in a small round tendon, which, going through the apex of the latter, is inserted into the head of the stapes.

It draws the stapes backwards, and perhaps fixes it more firmly by its contractions.

4. There is a fourth muscle mentioned by anatomists, the existence of which is more equivocal; it is called the Laxator Tympani Minor. It is said to arise from the superior margin of the orifice of the tympanum, and to be inserted into the processus brevis of the malleus. It is by some considered only as a ligament, to which opinion I am inclined.

Of the Lining Membrane of the Tympanum.

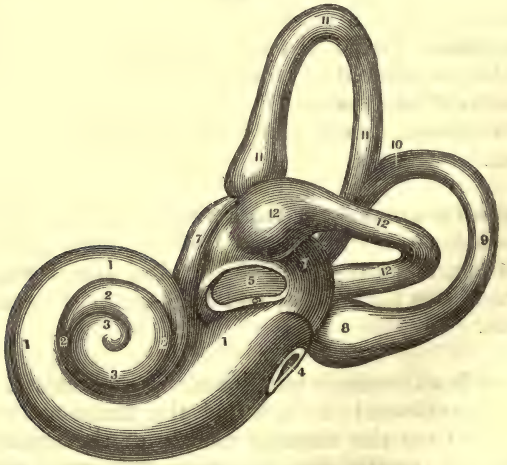
This membrane is in continuation of the lining membrane of the pharynx, being introduced into the tympanum through the Eustachian tube. It covers completely the surface of the tympanum, and is reflected over its little bones so as to give them a covering also: in addition to which, it lines such of the mastoid cells as communicate with the tympanum.

This membrane is extremely delicate: on its surface, adjacent to the bones, it is somewhat fibrous, and thereby resembles periosteum; but the other surface has the characters of the mucous membranes generally, in the nature of its secretion, and in its vascularity, which is very strongly marked in inflammations, and by fine injections. Bichat mentions that in certain catarrhal affections its mucous secretion is so abundant as to fill the whole cavity of the tympanum, and that without ulceration. Sometimes, in such cases, the membrane of the tympanum is ruptured, and the discharge finds its way out through the meatus externus, presenting itself in a purulent state, as if an abscess had formed in the ear.

SECT. III.—OF THE LABYRINTH.[1]

The Labyrinth (*labyrinthus*) is placed on the inner side of the tympanum, in the thickness of the petrous bone. Its exterior parietes are

Fig. 300.



A view of the Labyrinth of the Left Ear of a Fœtus of eight months, as seen from above.—Magnified four diameters. 1, 2, 3. The cochlea. 1, 1. Its first turn. 2, 2. Its second turn. 3, 3. Its third or half turn. and apex or cupola. 4. The foramen rotundum. 5. The foramen ovale. 6. A groove around it. 7, 7. The vestibule. 8, 9, 10. The inferior semicircular canal, with its ampulla at 8. 11, 11. The superior semicircular canal. 12. The external semicircular canal.

bone, but internally there is a membranous structure, having, in many respects, the same shape. It is got at with great difficulty in the adult,

[1] Antonio Scarpa, Disquisit. de Auditu et Olfacto.

owing to the compactness of the petrous bone which envelops it; but in the fœtus of the full period, where it is almost as large as in the adult, the surrounding bone is of a softer and more spongy texture, and may be pared away with a penknife without much trouble. In the latter case, the parietes of the bony labyrinth remain about the thickness of an egg-shell, and have very much the same degree of consistency and strength.

The bony labyrinth consists of three portions: the Vestibulum, the Semicircular Canals, and the Cochlea.

The *Vestibulum* is the cavity to which the foramen ovale leads; it, with the cochlea, occasions the protuberance into the tympanum, known as the promontory. It is an irregular rounded excavation, the surface of which is impressed by its contents; thus, at the superior posterior and external part, next to the semicircular canals, there is a superficial Fossa, called, from its shape, Semi-Elliptica; and at its anterior and inferior part, nearer the cochlea, another, called Fossa Hemispherica. These fossæ are marked off from each other by a ridge of bone, at the lower end of which there is a third fossa between the other two, called, by Sœmmering, Cavitas Sulciformis.

There are seven orifices belonging to the vestibulum besides the foramen ovale; five at its posterior part leading into the semicircular canals; one anteriorly leading into the upper scala of the cochlea: and the last placed in its internal paries is the aqueduct of the vestibule. In addition to these orifices, the parietes of this cavity are cribriform in the fossa semi-elliptica and near the foramen rotundum.[1]

The Semicircular Canals (*canales semicirculares*) are at the posterior extremity of the vestibulum. They are three in number, and are named, from their relative situation, Superior or Anterior, Posterior or Inferior, and External. Each one forms rather more than the half of a semicircle, and has its cavity about half a line in diameter: their orifices are somewhat dilated beyond this measurement. The apparent thickness of their parietes is greater in the adult than in the infant.

The Superior Canal runs from without inwards and backwards. Its anterior orifice is above the fenestra ovalis, and is enlarged into an ampulla or elliptical cavity. At its posterior extremity, it joins the upper extremity of the Inferior canal, so that a common trunk is thus formed, the orifice of which is at the internal posterior part of the vestibulum, and is dilated into the shape of a funnel.[2]

The Posterior or Inferior Canal is nearly vertical; has its concavity in front, and its convexity behind, and joins, as just remarked, with the superior; its inferior orifice, which is near the foramen rotundum, is also enlarged into an ampulla or elliptical cavity. It is the longest of the three canals, and has its ends nearer together.

The External Canal is nearly horizontal, and is placed in the space left by the divergence of the other two. It is the shortest and the largest

[1] Ant. Scarpa, loc. cit.

[2] Scarpa, loc. cit.

of the three. Its exterior orifice is also enlarged into an ampulla or elliptical cavity, and is just behind the foramen ovale, or below the ampulla of the upper canal; the internal orifice is below the common opening of the other two canals.

It is the union of the superior and of the posterior canals at one of their extremities which reduces the number of openings into the vestibulum, from the semicircular canals, to five instead of six.

The *Cochlea* forms the fore part of the labyrinth, and resembles very strongly the shell of the common snail. Its base is the bottom of the meatus auditorius internus, and its apex is directed towards the cavity of the tympanum, so that the axis of the cochlea is turned downwards and outwards. It consists in a conoidal tube wound spirally twice and a half, around a column of bone termed the Modiolus.[1] The tube then of course diminishes in size from the base to the apex of the cochlea.

This conical tube is divided in its length by a plate called Lamina Spiralis. Of the two tubes thus formed, and called Scalæ or stairs, one is above the other. The inferior is the larger, and communicates at its base, through the foramen rotundum, with the tympanum; it is, therefore, called Scala Tympani. The other tube communicates at its base with the vestibulum, and is, therefore, called Scala Vestibuli.

The Modiolus is of a conical shape, and cribriform: one canal, larger than the others, runs from its base to its summit. This canal is surrounded by many others, which diminish successively as they advance towards the apex, and terminate in orifices upon the lamina spiralis. This cribriform arrangement of the modiolus is the Tractus Spiralis Foraminulosus. The base of the modiolus is towards the meatus auditorius internus; and its point does not go to the apex of the cochlea, but stops short of it, and is expanded into a cavity called the Infundibulum, the base of which is towards the apex of the cochlea. That portion of the apex of the cochlea which covers over the infundibulum is the Cupola.

It was just mentioned that the lamina spiralis divides the cochlea into two tubes; the septum thus formed, does not, however, run their whole length, for it ceases in the infundibulum by a small crooked process of bone, called the Hamulus Cochleæ. The lamina, when examined by strong glasses, is seen to consist of four distinct structures called its Zones. 1. The Zona Ossea is next to the modiolus, and is composed of two bony laminæ, with an intermediate diploic structure, in which are the canals for transmitting the filaments of the portio mollis or auditory nerve. 2. On the outer side of this is the Zona Coriacea, the structure of which is cartilaginous. 3. The Zona Vesicularis, said to contain in its cells a pellucid fluid. 4. The Zona Membranacea, which is probably only the lining membrane of the cochlea, and completes the lamina spiralis on its edge next to the periphery of the cochlea. Some very respectable anatomists pass over this minute

[1] From its being like the nave or stock of a wheel in which the spokes are fastened.

distinction in the structure of the septum, and merely divide it into Zona Ossea, and into Zona Mollis.

Of the Membranous Labyrinth.

The whole internal face of the bony Labyrinth is lined by a very delicate and vascular membrane, which is more distinct during the early periods of intra-uterine life. Besides this, there is a membranous labyrinth, consisting in three semicircular canals, nearly filling up the cavities, and having the same shape and general arrangement of the bony canals; and in two sacs contained in the vestibule.

The semicircular Membranous Canals have also at their ends the elliptical enlargements called ampullæ; they terminate by both extremities in the sac of the superior part of the vestibule. This sac is generally called, from its shape, Sacculus Ellipticus; and by Scarpa, from its function, the Alveus Communis. In front of the Sacculus Ellipticus, nearer the cochlea, and opposite the foramen ovale, is the Sacculus Sphericus; it is a complete bag, having no communication with the other, or with the membranous canals. Both of the sacs adhere to the vestibulum at their posterior parietes.

The sacs of the vestibule and the membranous semicircular canals are filled with a very fluid transparent liquid, the Endolymph. According to the observations of M. Ribes, it is not necessary to the function of hearing that this fluid should be so abundant as to distend the membranous labyrinth, inasmuch as in his dissections he met with individuals in whom the latter was only half filled, and yet they had heard very well. He also

Fig. 301.

A view of the Labyrinth of the Left Side laid open, and showing its contents.—This figure has the same references as Fig. 300, and is the same as it, except that the elliptical sacs and the membranous semicircular canals, &c., are seen within the bony cavity.

met with similar cases in which the fluid was abundant in the vestibulum, but deficient in the canals, and the reverse. Corresponding observa-

tions have been made by M. Brugnone, of Turin,[1] where he had adopted the precaution of previously freezing the bone, so that none of the fluid could be said to have been lost by accident. From the frequency with which this deficiency was observed, his opinion seems to be well founded, that it is the most natural state of the labyrinth.

The parietes of the membranous labyrinth are very thin and transparent; there is a very loose cellular tissue between them and the bone; and they are susceptible of being highly colored by injection.

A fluid of the same character with the preceding, the Perilymph, also fills the scalæ of the cochlea, and extends itself into the bony vestibulum and the bony semicircular canals upon the outer surface of the membranous labyrinth.

In the Sacculus Ellipticus are found numerous small crystalline pulverulent masses of a calcareous composition. They are thought to contribute to the auditive function of the Labyrinth, and are called Otoconites (*otoconie*)[2] from their powdered state and position in the ear, in contradistinction to the term *otolites* or ear stones, as seen in fishes and amphibia. Huschke[3] calls them the auditive crystals. Siebold made a singular observation concerning them in the bivalves and snails, to wit, that during the life of the animal they had a remarkable motion.[4] This observation has been confirmed in similar animals by Dr. Leidy, who informed me that the motion was vibratile and centripetal during the life of the animal; but, upon life ceasing, these crystals dispersed and then remained stationary.

Of the Aqueducts of the Ear.

The Aqueducts (*aquæductus*) of Cotunnius, as they are called after their discoverer, are two small canals which go through the petrous bone from the labyrinth. There is one for the vestibule, and another for the cochlea.

The Aqueduct of the Vestibulum commences in the latter cavity somewhat in advance of the common orifice of the two semicircular canals; it goes inwards, and opens on the posterior face of the petrous bone, behind the meatus internus. It enlarges gradually in its course, which causes it to have somewhat of a triangular shape, and it is lined by a continuation of the dura mater. It is about four lines long.

The Aqueduct of the Cochlea commences in the Scala Tympani, near the foramen rotundum, and, enlarging in its course, terminates on the under surface of the petrous bone, in the internal margin of the jugular fossa, at the root of the little spine which separates the eighth pair of nerves from the jugular vein.

The anatomist[5] from whom these canals were named, and who first described them, was under an impression that the fluid of the labyrinth always filled it completely; and that without a sort of waste gate for it on an occasion, the vibration of the stapes would be prevented from put-

[1] Mem. de Turin, 1805—1808.
[2] Breschet, Mém. de l'Acad. Royale de Méd. tom. 5.
[3] Traité de Splanch. p. 812.
[4] Wagner's Physiol. p. 532, London, 1844.
[5] Dominici Cotunnii, Anat. Dissert. de Aquæduct, Naples, 1761.

ting the fluid in motion, and consequently hearing must cease. These canals, the existence of which is sufficiently obvious in many subjects, were, therefore, considered by him as the desired avenues for the discharge of the superabundant fluid, and his theory and descriptions were very generally adopted. At a later period, the investigation of this subject was renewed by MM. Ribes and Brugnone, and their observations are considered by the French anatomists to have proved conclusively the error into which Cotunnius and others have fallen.

In regard to the aqueduct of the vestibule, M. Ribes found it only in three instances emptying into the vestibule; for most commonly it leads, after a course somewhat tortuous, into the spongy structure of the petrous bone, at the posterior part of the vestibule, and smaller canals diverge from it in different directions. In the cases where it was connected with the labyrinth, it was so by several orifices leading into the vestibule, and into the posterior semicircular canal. He did not find this canal in the fœtus, nor till some time after birth, and from his injections he believes that, in all cases, it and its branches are only intended to convey blood-vessels throughout the petrous bone and to the labyrinth.

In regard to the supposed aqueduct of the cochlea, M. Ribes found it also diverging into collateral branches, and occupied by blood-vessels, which are distributed to the spongy structure of the petrous bone, and to the tympanum.

In my own researches on this point, on the dried bones, the canals, as described by Cotunnius, were closed at the labyrinth, in the case of subjects advanced in life; but in the middle aged, and in infantile specimens, I was more successful in tracing them fairly into the labyrinth, and have the preparations in the Wistar Museum. At the same time, I think it much more probable that they only contained blood-vessels, and that Cotunnius was in error. Besides these vascular canals, M. Ribes has described some others having the same use.

SECT. IV.—OF THE NERVES OF THE ORGAN OF HEARING.

The nerves which pass through the petrous bone, and are either wholly or partially spent upon the organ of hearing, come from three sources: 1. The Auditory Nerve; 2. The Portio Dura; 3. The Trigeminus, or Fifth Pair.

The Meatus Auditorius Internus conducts the first two, and has its bottom divided by a ridge into two fossæ, of which the upper one is the smaller. This bottom, it has been observed, corresponds with the base of the modiolus, and is cribriform. One foramen, larger than any of the others, and in the superior fossa, transmits the portio dura or facial nerve: all the others are occupied by the filaments of the auditory nerve.

1. The Auditory Nerve divides at the bottom of the meatus into fasciculi of filaments; one of which penetrates into the vestibulum through the foramina behind that for the portio dura, and is distributed upon the sacculus ellipticus, and upon the ampulla of the superior and of the

exterior membranous canal; other filaments get to the sacculus sphericus; and a third fasciculus of filaments is distributed to the ampulla of the posterior membranous canal. These several filaments are said to preserve, when they first penetrate into the bony labyrinth, a fibrous appearance, and are interlaced; they also penetrate the parietes of the membranous labyrinth, and have their extremities bathed in its fluid, in which place they are converted into a soft pulp, resembling mucus, or the retina.

Another very considerable fasciculus of filaments penetrates into the canals of the modiolus, and enters through them into the cavity of the cochlea, along the Zona Ossea, and between its tables; they terminate also by a soft pulp on the internal face of the lining membrane of the cochlea. One of these filaments, conspicuous for its size, goes through the central canal of the modiolus and terminates in the infundibulum.[1]

The final termination of the auditory nerve is considered by Treviranus to be papillary, and by Breschet to be looped, surrounded by granules.

2. The Facial Nerve, or Portio Dura, is only connected to the organ of hearing by sending a few filaments to the muscles of the bones of the tympanum. The canal of the petrous bone, through which it passes, is very crooked; beginning at the larger orifice of the meatus internus in its upper fossa, it passes outwards until it nearly reaches the Vidian foramen, on the front of the petrous bone; it then turns very abruptly backwards, forming an angle, and is continued in a circuit around the superior and the posterior parietes of the tympanum, till it terminates in the stylo-mastoid foramen. Its course is marked by a ridge projecting into the tympanum, above the foramen ovale, and passing between the semicircular canals and the cochlea. This canal has been very much misnamed by calling it the aqueduct of Fallopius, as its only use is to conduct nerves and blood-vessels. It is lined by a delicate fibrous membrane between which, and its contained parts, there is so little adhesion that the latter may be drawn out entire.

The facial nerve is joined at the Vidian foramen by the Vidian nerve, shortly after which it sends a filament to the tensor tympani muscle.[2] As it passes the base of the pyramid, it detaches another filament, which supplies the stapedius muscle.

Shortly after this, it is abandoned by the Vidian nerve, and does not give off any more branches till it escapes from the stylo-mastoid foramen when it sends off a branch, the posterior auricular (*auricularis posterior*), which is distributed by filaments, some of which run into the mastoid process; other branches mount on the side of this process, to the skin which covers it, and to the occipital muscle; others go to the concha of the ear, being spent upon its skin, upon the posterior auricular muscle, and some of them, penetrating the pinna, are lost upon the integuments of the meatus externus. The trunk of the facial then goes to its destination on the face.

[1] For a knowledge of the minute distribution of the auditory nerve, the profession is signally indebted to the distinguished Scarpa, in his Disquisitiones de Auditu et Olfactu.

[2] The tensor tympani is also supplied by a nerve from the Third Branch of the Trigeminus.

3. The Chorda Tympani or Superficial Petrous Nerve is a branch of the Pterygoid branch of the Trigeminus, and leaves it near the anterior part of the carotid canal of the petrous bone. It, as just mentioned, under the name of Vidian nerve, joins the facial nerve at the angle of the canal of Fallopius; the facial nerve there enlarges somewhat so as to form a small grayish-red ganglion, called the ganglion geniculatum. The chorda tympani continues to adhere closely to the facial, almost to the stylo-mastoid foramen; it then abandons the facial nerve at a very acute angle, and running upwards and forwards, gets into the cavity of the tympanum through the apertura chordæ, on a level with, but a line or two exterior to, the pyramid. It then crosses the tympanum nearly horizontally, between the long crus of the incus and the handle of the malleus, adhering to the latter so as to be affected by its vibrations. At the fore part of the tympanum, it anastomoses with some other filaments of the fifth pair, by which its size is augmented, but it gives no branches to the parts contained in the tympanum. It then issues from the latter cavity through the glenoid foramen, and descending a short but somewhat variable distance along the ramus of the lower jaw, terminates by anastomosing at an acute angle with the lingual branch of the trigeminus.

To Mr. John Hunter is due the merit of having traced the continuity and identity of the Vidian nerve with the chorda tympani. The continental anatomists vary in their views of the chorda tympani, but they generally agree in regarding the chorda tympani as a filament from the facial, just before the latter gets out of the stylo-mastoid foramen.

The Vidian Nerve, or Superficial Petrous, also traverses the tympanum in another place. Just below the posterior extremity of the Eustachian Canal, there is a small foramen, which leads upwards to the superior surface of the petrous bone, and downwards to a small gutter upon the promontory: this gutter is converted into a canal that opens upon the under surface of the petrous bone, between the carotid canal and the jugular fossa. Through the course indicated, passes a filament from the superficial petrous nerve: this filament is joined by another detached from the sympathetic while in the carotid canal, and the two communicate at the base of the cranium with the ganglion of the glosso-pharyngeal nerve.[1] These filaments were discovered by Professor Jacobson, of Copenhagen, and form what is now called the Anastomosis of Jacobson.

[1] Meckel, Man. D'Anat. vol. iii. p. 174. Jacobson, Supplem. Act. Hafn. vol. v. p. 292, an. 1818.

BOOK IX.

PART IV.

SPECIAL ANATOMY OF THE NERVES.

CHAPTER I.

OF THE NERVES OF THE ENCEPHALON.

SECTION I.

THE course and distribution of the first pair, or the olfactory nerves, have been described fully in the account of the brain and nose.

SECT. II.—NERVUS OPTICUS.

The Optic Nerve, as mentioned in the account of the basis of the brain, gets into the orbit by the optic foramen, and is there entirely surrounded by the origins of the muscles of the eyeball. It then describes a slight curvature, of which the convexity is outwards, and runs forwards for an inch, when it penetrates into the ball of the eye, where it gives origin to or expands into the retina. Between the muscles and it, except at their origins, there is a mass of adipose matter.

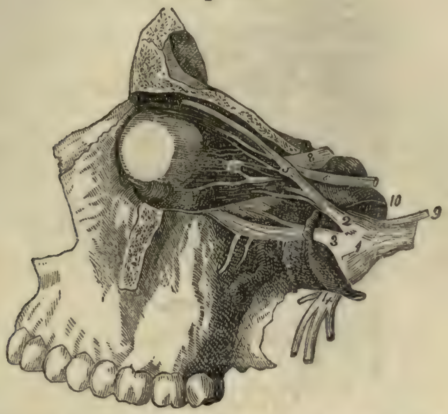
SECT. III.—NERVUS MOTOR OCULI.

The Nervus Motor Oculi (*oculo-motorius*), or Third Nerve, having reached from the basis of the brain to the external side of the cavernous sinus, is placed there within and above the optic nerve and the sixth pair; it then changes its direction, and penetrates through the sphenoidal foramen or fissure into the orbit, on the outer side of these nerves, and below them. The trunk is sometimes connected by filament with the carotid plexus of the sympathetic in the cavernous sinus.

The motor oculi divides, in the sphenoidal foramen, into two branches, one above the other. The first crosses over the optic nerve and the nasal branch of the ophthalmic, having some anastomoses with the latter, and then distributes its filaments upon the rectus superior muscle : some

of them also penetrate the latter to get to the levator palpebræ superioris. The second branch is much larger than the first. It passes

Fig. 302.



A representation of some of the Nerves of the Orbit, especially to show the lenticular ganglion (Arnold).—1. Ganglion of the fifth. 2. Ophthalmic nerve. 3. Upper maxillary. 4. Lower maxillary. 5. Nasal branch, giving the *long root* to the lenticular ganglion. 6. Third nerve. 7. Inferior oblique branch of the third connected with the ganglion by the *short root*. 8. Optic nerve. 9. Sixth nerve. 10. Sympathetic on the carotid artery.

between the optic nerve and the rectus inferior muscle, and is subdivided into three fasciculi: one for the rectus internus muscle; another for the rectus inferior; and a third, which is the longest and the smallest, for the obliquus inferior muscle. The latter fasciculus, not far from its root, gives off a filament, which, going along the external margin of the optic nerve, runs into the posterior margin of the lenticular or ophthalmic ganglion, and is its short root.

The Lenticular Ganglion is situated on the outer side of the optic nerve, in the orbit of the eye, and is about a line in diameter, being flattened. Two nerves concur to form it: the branch just alluded to, from the motor oculi, and one from the ophthalmic division of the trigeminus. From this ganglion arise the most of the ciliary nerves; which, as stated, are about twenty in number, and go to the choroid coat of the eye and to the iris. A filament not unfrequently connects this ganglion with the carotic or cavernous plexus.

SECT. IV.—NERVUS TROCHLEARIS.

The Nervus Trochlearis, or fourth Nerve, having got into its canal in the cavernous sinus, as it goes along the internal margin of the ophthalmic nerve, receives there a small filament from it,[1] and some filaments from the carotid plexus of the sympathetic. It is said by Bidder to send from this region some filaments to the tentorium which may be traced as far as the lateral sinus of the dura mater. It then

[1] Sœmmering, Icones Oculi Humani.

rises a little, and enters the orbit at the internal extremity of the sphenoidal foramen, and, going forwards, next to the periosteum of the

Fig. 303.

The Nerves in the Orbit above the muscles, brought into view by removing the roof of the Orbit and the Periosteum (Arnold).—1. Fifth nerve. 2. Ophthalmic branch of same nerve. 3. Third nerve. 4. Fourth nerve. 5. Optic nerve. 6. Sixth nerve. *a*. Internal carotid artery.

upper part of the orbit, it enters into the superior oblique muscle of the eye, near its middle, and is distributed upon it. This nerve augments in volume as it advances towards its destination, and is sometimes blended with the ophthalmic division of the trigeminus.

SECT. V.—OF THE NERVUS MOTOR EXTERNUS.

The Nervus Motor Externus, or sixth Nerve, having got into the cavernous sinus, is placed at the external side of the internal carotid artery, and adheres closely to it. It there sends off one or more filaments, which follow the internal carotid artery through its canal, and anastomose in their descent with a branch of the pterygoid nerve: the junction of these two forms the upper part of the great sympathetic nerve, and runs down to the superior cervical ganglion of the sympathetic in two or more filaments generally. The sixth nerve enters the orbit through the sphenoid foramen, and is there closely connected with the nervus Motor Oculi and the Nasal nerve. It penetrates into the substance of the rectus externus muscle, and is entirely distributed upon it; with the exception that it sometimes sends a filament to the ophthalmic ganglion. While in the cavernous sinus, several filaments pass between it and the carotid plexus, and it is connected in that way by one from Meckel's Ganglion and one from the ophthalmic nerve.

SECT. VI.—OF THE NERVUS TRIGEMINUS.

The Trigeminus, Fifth Nerve, or Trifacial, having formed the ganglion of Gasser (*plexus gangliformis*), on the side of the petrous bone, then

divides, as mentioned, into three large trunks, the foremost of which is the Ophthalmic Nerve: the second fasciculus is the Superior Maxillary; and the third the Inferior Maxillary Nerve.

Some filaments are sent from the Gasserian Ganglion to the plexus caroticus, and also in company with recurrent filaments of the fourth, to the tentorium, as stated.

The Ophthalmic nerve, or the first division of the trigeminus, is smaller than either of the other two, and comes from the superior part of the plexus gangliformis. It passes along the external border of the cavernous sinus, and penetrates the orbit through the sphenoidal foramen, on the outer side of, and near the nervus motor oculi.

In its whole course it is united to the trochlearis nerve by close cellular membrane. It sends a filament to the Trochlearis nerve, and

Fig. 304.

A plan of the Branches of the Fifth Nerve, modified from a sketch by Sir C. Bell.—*a*. Submaxillary gland, with the submaxillary ganglion above it. 1. Small root of the fifth nerve, which joins the lower maxillary division. 2. Larger root, with the Gasserian ganglion. 3. Ophthalmic nerve. 4. Upper maxillary nerve. 5. Lower maxillary nerve. 6. Chorda tympani. 7. Facial nerve.

also a filament in company with the recurrent or tentorial branch of the latter. It receives filaments from the carotid plexus, and then proceeds to the orbit. While engaged in the sphenoidal fissure it separates into three branches—the Nasal, the Lachrymal, and the Frontal.

The Nasal branch of the ophthalmic is between the other two in size. It ascends obliquely above the optic nerve to gain the internal face of the orbit of the eye, and then passes forwards just below the superior oblique muscle, involved in a quantity of adipose matter.

Shortly after its origin, the nasal nerve detaches a branch (*ramus ciliaris*), which, situated at the external margin of the optic nerve, runs into the ophthalmic or lenticular ganglion, and constitutes the long root; it then sends off one or more filaments, which, without communicating with this ganglion, penetrate into the eyeball, and are amongst the ciliary nerves which have been described.

The nasal nerve continuing to pass forward along the internal paries of the orbit, when it reaches the anterior internal orbitary foramen, detaches through it the *internal nasal* or ethmoidal branch, which, thus getting into the cavity of the cranium, goes along side of the crista galli, and passes into the nose through an anterior hole of the cribriform plate;—then descends along the fore part of the nose, on the outer side of the Schneiderian membrane, and is spent by ramifications upon the contiguous portions of the latter: some of the terminating branches reach the tip of the nose and the alæ.[1]

The nasal nerve, after the ethmoidal branch is sent off, is frequently called *external nasal*, or nervus infra-trochlearis. It continues to advance along the under margin of the trochlearis muscle, and gets to the trochlea, near which it divides into an upper and an under ramuscule; from them filaments proceed to the upper and under eyelids, to the lachrymal sac, the lachrymal caruncle, the tunica conjunctiva, and the muscles on the root of the nose. These filaments anastomose with the terminating branches of the frontal nerve, the facial, and the infraorbitary. According to Dr. G. Trasmondi,[2] of Rome, two filaments may be traced very distinctly from the external nasal nerve to the Tensor Tarsi muscle of the lachrymal sac. They adhere to the muscle by means of cellular tissue, and pass on to its bifurcated extremities and to the puncta lachrymalia.

The Frontal Nerve is the largest of the three branches of the ophthalmic. It proceeds forward between the levator palpebræ superioris and the contiguous part of the orbit, and in this course is divided into two branches, the internal and the external frontal nerve. The former approaches the trochlea of the upper oblique muscle, and detaches a filament to join with one from the External Nasal nerve. Other filaments are detached to the upper eyelid, some of which anastomose with filaments from the Lachrymal nerve. The internal branch of the frontal, called the nervus supra-trochlearis, then issues from the orbit close by the trochlea, and, in ascending, is lost upon the occipito-frontalis, the corrugator supercilii, and the orbicularis palpebrarum muscle. The external branch of the frontal being the supra-orbitary nerve issues from the orbit, through the supra-orbitary foramen. It quickly detaches a filament, which goes outwardly to anastomose with the facial; the remaining part of the nerve is distributed to the occipito-frontalis, the orbicularis, and to the corrugator supercilii, to the integuments of the forehead, and to the scalp. This distribution, according to Bichat, is best followed by detaching the skin, the muscles, and

[1] See Nerves of the Nose.

[2] Intorno la scoperta di due nervi del Occhio umano ragguaglio del Dr. Giuseppe Trasmondi, Professore di Anatomia Practica nel ven. ospidale della Consolazione, Roma, 1823.

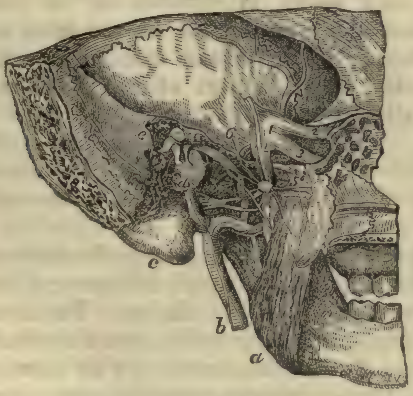
the periosteum from the cranium, from behind forwards as far as the orbit.

The Lachrymal Branch of the ophthalmic nerve goes forwards along the external side of the orbit near the superior margin of the rectus externus muscle. In this course it sends off a filament through the spheno-maxillary fissure, which unites with one from the second branch of the fifth pair; it afterwards sends off another filament, which, passing through a foramen in the malar bone, anastomoses with a filament of the facial nerve. What remains of the lachrymal nerve is then distributed by several filaments upon the lachrymal gland, the upper eyelid, and some of them reach the conjunctiva.

Second Branch of the Trigeminus.

The second Branch of the Fifth Nerve (*nervus maxillaris superior*), arising from the middle of the plexus gangliformis, or ganglion of Gasser or Casser, and also, in part, from the trunk formed from the posterior root of the trigeminus, gets from the cranium through the foramen rotundum of the sphenoid bone. While still in the cranium it sometimes forms an anastomosis, described by Laumonier, with the beginning of the sympathetic nerve, but generally it does not detach any filament till it reaches the pterygo-maxillary fossa.

Fig. 305.



The Otic Ganglion seen from the inner side. (From Arnold.)—*a*. Internal pterygoid muscle. *b*. Carotid artery with the sympathetic. *c*. Mastoid process. *d*. Membrane of tympanum. *e*. Bones of tympanum. 1. Gasserian ganglion. 2. First division of fifth. 3. Second division. 4. Third division. 5. Branch to tensor palati. 6. Small superficial petrosal nerve. 7. Chorda tympani. The nerve of the internal pterygoid muscle is seen on the muscle.

At a short distance after its exit from the cranium, it gives off a small filament, the Nervus Subcutaneus Malæ, which ascends into the orbit through the spheno-maxillary fissure, and then divides. One of the branches, the malar, anastomoses with the lachrymal nerve, and leaves filaments with the lachrymal gland; it then gets, by one or more filaments, through the holes of the malar bone to the face, and terminates on the orbicularis muscle and the skin of the cheek, anastomosing with the extremities of the facial nerve. The other branch, the temporal, gets into the temporal fossa by penetrating the internal part of

the malar bone, and, having anastomosed with a branch of the inferior maxillary nerve, it goes outwards and backwards, becomes superficial by penetrating the temporal aponeurosis, and terminates on the integuments of the temple, anastomosing there with the branches of the facial nerve.

The superior maxillary then divides into two trunks much larger than the preceding, and of a volume nearly equal; the Infra-Orbitar and the Pterygo-Palatine.

The Infra-Orbitar (*nervus infra-orbitalis*) passes forwards, with a slight ascent, to the posterior part of the orbit, and enters the infra-orbitar canal. As it is about engaging in the latter, it detaches a considerable branch, the Posterior Dental. This branch descends a little distance, externally, along the posterior paries of the maxillary sinus, then penetrates into the cavity of the latter. It terminates by filaments, some of which supply the lining membrane of the antrum; others pass through the little canals leading to the three large grinders, and enter the roots of the latter: others go to the corresponding gums. One branch goes along the outer side of the sinus to anastomose with the anterior dental nerve. The posterior dental, before it enters the bone, also detaches a branch of some size, which winds around the tuberosity of the maxillary bone, and is spent upon the buccinator muscle and upon the gums.

The infra-orbitary nerve afterwards, in its course through the canal, sends off the Anterior dental nerves from one or more roots. Some of them detach fibres to the mucous membrane of the nose, where it covers the anterior part of the inferior turbinated bone. With this exception, they are distributed, through their appropriate canals in the bone, to the incisor and canine teeth, and to the corresponding gums. The small molar teeth are most frequently supplied by a union of filaments from the anterior and posterior dental nerves.

The infra-orbitar nerve, on issuing from the infra-orbitar foramen, is most frequently found already divided into several fasciculi, which may be classed into superior and into inferior. The former, called Palpebral, radiate externally and internally, into filaments which supply the lower eyelid. One of these filaments may be traced to the end of the nose, where it anastomoses with the internal nasal branch of the ophthalmic: another, which terminates about the internal angle of the eye, anastomoses there with the external nasal nerve. Others of its terminating filaments anastomose with the extremities of the facial nerve on the eyelid. The inferior fasciculi are more numerous and large than the superior. They descend upon the face covered by the levator muscles of the upper lip, and from their distribution are called Labial. The most internal of these fasciculi terminate on the skin, the muscles, and the beginning of the mucous membrane of the nose, where they anastomose with the extremities of the internal nasal nerve. The middle fasciculi go to the muscles of the upper lip and the skin of the latter, and to its mucous glands. The external fasciculi go to the zygomatic muscles and to the contiguous skin. All the foregoing branches of the infra-orbitar nerve anastomose with the extremities of

the facial, and are so minutely distributed to the skin and muscles of the face, that it would require a very protracted description to point them out particularly.

The Pterygo-palatine nerve (*nervus pterygo-palatinus*) descends in the pterygo-maxillary fossa as a single or a double trunk, from its root to the outside of the spheno-palatine foramen, and there forms the ganglion of Meckel,[1] or the spheno-palatine ganglion, the existence of which is not constant. From this ganglion, or from the nerve itself, proceed several branches, to wit:—

A filament, described by Bock, is detached from it, which enters into the sphenoidal sinus to be distributed on its lining membrane, and sometimes to anastomose with the motor externus oculi.

Then arise the Spheno-palatine branches, which enter through the spheno-palatine foramen the nose, and are distributed upon the mucous membrane of its septum and turbinated portions, after the manner described in the account of the nose.

The Vidian or Pterygoid Nerve (*nervus Vidianus, recurrens pterygoideus*) arises from the inferior part of the same ganglion, and is a recurrent branch, which goes backwards through the pterygoid foramen of the sphenoid bone. From it there arise some filaments which get to the mucous membrane about the anterior orifice of the Eustachian Tube, either through the spheno-palatine foramen, or by small foramina in the pterygoid process of the sphenoid bone. They are sometimes united into a single trunk, called pharyngeal, by Bock. The Vidian nerve, while still in its canal, then divides into two trunks, the superficial and the deep petrous.

The Superficial Petrous (*nervus petrosus superficialis*) traverses the cartilaginous matter at the point of the petrous bone, in the anterior foramen lacerum of the basis of the cranium, gets there into the cavity of the latter, continues its progress backwards on the superior face of the petrous bone, in a gutter marked on the bone, and disappears through the Vidian foramen. It, in a short space, reaches the aqueduct of Fallopius, and continues to adhere to the facial nerve till the latter almost reaches the stylo-mastoid foramen: it then abandons the facial nerve, and, as mentioned in the account of the ear, traverses the tympanum under the name of chorda tympani: and, finally, emerging at the glenoid foramen, it runs to associate itself with the lingual branch of the trigeminus. The superficial petrous, in the early part of its course, at the point of the petrous bone, detaches one or more filaments to the sympathetic in the carotid canal.

The Deep Petrous (*nervus petrosus profundus*) is larger than the other. It also penetrates through the cartilaginous matter at the point of the petrous bone, and enters the cavity of the cranium under the dura mater. It then advances to the internal carotid artery, and anastomoses there with a filament from the motor externus or sixth

[1] Discovered by Meckel, 1749.

nerve. This anastomosis, as stated, is commonly called the beginning of the sympathetic nerve.

The Palatine Nerve (*nervus palatinus*) proceeds from the inferior part of the ganglion of Meckel, and goes to the soft palate of the mouth through the posterior palatine foramen. In this course, it detaches several filaments to the Schneiderian membrane, which reach it either through the spheno-palatine foramen, or by perforating the nasal lamella of the palate bone. These are described in the account of the nose.

The trunk of the palatine nerve, having reached the roof of the mouth, bends forward, and is divided into many filaments, some of which are distributed along the gums of the upper jaw, others are distributed on the lining membrane of the hard palate and upon its mucous glands.

There are two other nerves, which arise either immediately from the palatine, or from the ganglion of Meckel, and go to supply the soft palate. They are called the *smaller palatine.* One of them, having proceeded for a short distance in the posterior palatine canal, departs from it in a little canal of its own, which opens behind the hook of the internal pterygoid process. It then radiates into filaments, which supply the tonsil gland and the muscular and membranous structure of the soft palate. The other smaller palatine also traverses, after the same manner, its own canal, and is likewise distributed to the tonsil gland and to the soft palate.

Third Branch of the Trigeminus.

The Third Branch of the Trigeminus (*nervus infra-maxillaris*) is the largest of the three. It arises from the posterior inferior part of the ganglion of Gasser, and, having anastomosed with the cavernous ganglion of the sympathetic nerve, by filaments which are not constant, it emerges from the cranium through the foramen ovale of the sphenoid bone. A portion of this branch, as mentioned, the Motor or smaller root, does not enter into the composition of the ganglion of Gasser, but proceeds immediately from the pons Varolii.

The inferior maxillary nerve, at its exit from the foramen ovale, is covered by the pterygoideus externus muscle, and commonly divides there into two branches, one anterior and the other posterior, or else sends off two sets of branches—the first for the muscles of mastication, and the second set for the lower jaw and tongue.

The Anterior Branch, or set, which is much smaller than the other, radiates into five fasciculi; the masseter nerve; the two temporal; the buccal; and the pterygoid.

a. The Masseter Nerve is directed horizontally outwards and backwards, along the external margin of the pterygoideus externus, and in front of the temporo-maxillary articulation: it leaves some filaments with the latter, and then passing between the insertion of the temporal and of the external pterygoid muscle, over the concave edge of the bone, between the condyle and the coronoid process of the lower jaw,

it penetrates into the substance of the masseter muscle, and is distributed through it.

b. The two Temporal branches arise by a common fasciculus, but sometimes differently. They pass outwards, horizontally, between the external pterygoid muscle and zygomatic fossa. They then ascend on the side of the temporal bone, between it and the temporal muscle, and are distributed through the latter by a great number of filaments. Some of these filaments penetrate the aponeurosis, to anastomose with the superficial temporal nerves. One of them anastomoses with the Temporal Branch of the Subcutaneus Malæ, in the temporal fossa.

c. The Buccal Branch is the largest of the five. It advances between the pterygoid muscles, to which it furnishes a few filaments, and then descends between the temporal and external pterygoid muscle to the posterior part of the buccinator. It is principally distributed on the latter, upon the buccal glands, and the corresponding part of the lining membrane of the mouth. Some of its branches advance under the integuments of the face, as far as the commissure of the lips to the muscles there, and anastomose with the facial nerve.

d. The Pterygoid Branch is the smallest, and is distributed principally on the internal pterygoid muscle.

The Posterior Branch of the inferior maxillary nerve is so large, that it looks like a continuation of the trunk. It is divided into the superficial temporal, the inferior dental, and the lingual nerve.

a. The Superficial Temporal Branch is formed by the union of two fasciculi, between which passes the middle artery of the dura mater; the inferior of these fasciculi comes from the inferior dental nerve. The superficial temporal nerve is directed outwards, and winds horizontally around the posterior face of the neck of the condyle of the lower jaw, between it and the meatus auditorius externus. It is there divided into several small fasciculi, two or three of which penetrate into the substance of the parotid gland, and anastomose with the facial nerve or its ramifications: one or two others go backwards, penetrate between the bony and the cartilaginous meatus to the auditory canal, and are dispersed by fine filaments upon the concha, and the meatus externus. According to Bock, one of these filaments supplies the membrane of the tympanum, and also anastomoses with the chorda tympani. Another branch of the superficial temporal, which is the largest of any, traverses the parotid gland, and thereby becomes superficial, just in front of the external ear. It then divides into filaments, which follow the course of the superficial temporal artery, and thereby supply the middle part of the integuments on the side of the head. It anastomoses with the filaments of the frontal nerve, and with those of the occipital.

b. The Inferior Dental Nerve is placed between the other two branches, and exceeds them in size. It descends between the two pterygoid muscles, towards the posterior mental foramen. Just above the latter, it detaches a small branch, the Mylo-Hyoid, which occupies the small gutter on the bone leading downward from the posterior mental foramen. This branch sends a filament to the submaxillary gland, then passes between the anterior belly of the digastric muscle, and the mylo-

hyoideus, to both of which it gives filaments; and finally, winding over the base of the lower jaw in front, it is lost upon the muscles of the chin.

The inferior dental nerve then enters the posterior mental foramen, and divides into two branches, which run parallel with one another through the canal in the middle of the spongy structure of the bone, and send a great number of anastomotic filaments to each other. One of the branches, the dental, properly speaking, as it passes along the ends of the roots of the teeth, detaches a filament to each root, from the last grinder to the first incisor tooth inclusively: it also sends a filament to the gum intermediate to every two teeth. All of these filaments arise from the dental nerve, at places behind the points of destination; so that they have, before reaching the latter, to run forwards and upwards through little canals in the cellular structure of the bone.

The other branch of the inferior dental nerve is the mental; it does not advance so far forward in the bone as the preceding, but issues from it at the anterior mental foramen, and immediately is divided into two fasciculi, the inferior labial nerves. The internal fasciculus is distributed by filaments upon the muscles of the chin and lower lip, the contiguous lining membrane of the mouth and the labial glands. The external fasciculus rises upwards, and is distributed on the muscular structure, about the under part of the commissure of the lip, and to the contiguous lining membrane and glands of the mouth.

c. The Lingual Nerve descends in company with the inferior dental, but in advance of it, and diverging slightly. While between the two pterygoid muscles it receives the chorda tympani at a very acute angle. It then passes towards the side of the root of the tongue, deeply concealed by the angle of the lower jaw, and above the submaxillary gland, to which it gives some considerable filaments.

A ganglion called the *Submaxillary* (*ganglion glotticum, linguale, maxillare*), is formed here by one or more filaments of the lingual nerve, and from this ganglion proceed filaments to the submaxillary gland.

The Submaxillary Ganglion is so named from being placed upon the submaxillary gland. It is very small, and is derived from the Chorda Tympani, which, after joining the gustatory nerve, leaves it and unites to or forms this ganglion, with the assistance of some two or more filaments from the gustatory nerve, and one or two from the cervical portion of the Sympathetic. The ganglion also detaches forward filaments to join the gustatory nerve, and some in company also with the duct of the submaxillary gland.

The lingual nerve then proceeds forwards between the mylo-hyoideus and the hyoglossus muscle, and between the sublingual gland and the latter, having in front of it the excretory duct of the submaxillary gland. It anastomoses frequently with the hypoglossal nerve, sends several filaments to the lining membrane of the mouth, below the tongue, and to the sublingual gland. It then divides, or radiates, into seven or eight fasciculi, which run upwards and forwards on the side of the styloglossus muscle, and the genio-hyoglossus, and are finally spent by very fine filaments penetrating into the structure of the papillæ, on the upper surface of the tongue.

Otic Ganglion.—The third branch of the trigeminus, according to Dr.

Arnold, of Heidelberg, also forms, by several filaments, a ganglion called *Otic* (*ganglion Arnoldi*) near the foramen ovale. This ganglion is below the spinous process of the sphenoid bone, at the inner side of the nervus Infra-maxillaris and of the cartilage of the Eustachian tube, and sends off several filaments: one contributes to the nervous anastomosis of Jacobson,[1] which connects the superficial petrous, sympathetic, and glosso-pharyngeal nerves; another filament passes to the tensor tympani (*nervus ad tensor-tympani*), and is distributed upon it. Other filaments join the superficial temporal nerve: that part of it which supplies the membrana tympani. There is also an anastomosis with the portio mollis.[2] Its principal roots are from the nervus tympanicus of the glosso-pharyngeal, from the nervus pterygoideus internus of the inferior maxillary, and from the first cervical ganglion of the sympathetic.

SECT. VII.—NERVUS FACIALIS.

The Facial Nerve (*nervus facialis; portio dura septimi; par septimum*) having gained the meatus auditorius internus, passes in front of the auditory nerve into the canal of Fallopius, and winding through it, around the tympanum, it emerges at the stylo-mastoid foramen. The ganglion geniculatum is a marked point from the abrupt angle made there by the facial nerve and from its connections. Before this the facial has sent a filament or more to the portio mollis. At the point itself the ganglion is formed principally by the superficial petrous, for which see the account of the ear. From the ganglion, there proceeds the *small superficial petrous* nerve to the otic ganglion—this nerve receiving in its course a filament from Jacobson's (*nervus tympanicus*); and lastly, the ganglion receives a filament, Bidder's nerve (*nervus superficialis externus*), from the sympathetic branch attending the middle meningeal artery.

Afterwards the facial nerve gives off several branches, which are distributed as follows:—

a. The Posterior Auricular (*auricularis posterior*) arises near the stylo-mastoid foramen, as stated in the account of the Nerves of the Ear; and having sent several filaments into the mastoid process, it winds over the anterior face of the base of the latter, and divides into two fasciculi. The anterior is distributed in filaments upon the back of the external ear, the cartilaginous meatus, and the posterior auris muscle; the posterior ascends upon the mastoid portion of the temporal bone to the posterior belly of the occipito-frontalis muscle, and is spent by filaments to the latter, and to the corresponding integuments, anastomosing likewise with ramifications of the occipital nerve.

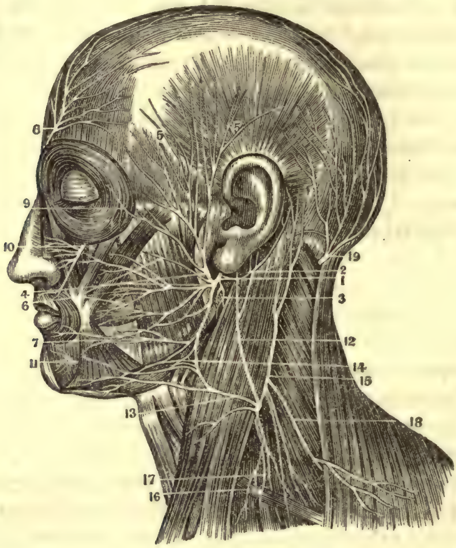
b. The Facial nerve then detaches filaments to the muscles of the styloid process, and to the posterior belly of the digastric muscle. It also sends filaments of anastomosis to the superior part of the sympathetic nerve; to the cutaneous cervical; and to ramifications of the glosso-pharyngeal, of the pneumogastric, and of the accessory.

The facial nerve, having given off the foregoing filaments and

[1] This nervous anastomosis is described with the Vidian Nerve.
[2] Am. Med. Jour., vol. v. p. 192.

branches, penetrates downwards and forwards into the substance of the parotid gland, where it is divided into a number of branches varying

Fig. 306.



A view of the Facial Nerve, together with branches of the Cervical Plexus, &c.—1. The portio dura or facial nerve escaping from the stylo-mastoid foramen. The parotid gland has been removed in order to show the nerve more clearly. 2. Its posterior auricular branch. 3. The stylo-hyoid branch. 4. The pes anserinus. 5. Temporo-facial branches. 6. Buccal branches. 7, 14. Cervico-facial branches. 8. Supra-orbitar nerve. 9. Malar branch. 10. The infra-orbitar nerve. 11. Mental branches of the inferior dental nerve. 12, 15. Branches of the cervical plexus. 13. Anterior branches of cervical plexus. 16. Descending branches of the cervical plexus. 17. The phrenic nerve. 18. The nervus accessorius of the eighth pair. 19. Occipital nerve from first cervical.

from two to five, which form a plexus by their anastomoses. This plexus is reinforced, as mentioned, by branches from the superficial temporal of the inferior maxillary, which wind around the neck of the lower jaw. It is then distributed to the side of the face in radiating clusters or columns of filaments, called the Temporo-Facial, the Buccal, and the Cervico-Facial.

The Temporo-Facial Nerves, or Branches, are hid, for some distance, in the upper part of the parotid gland, which they traverse below the neck of the lower jaw. They divide into filaments, some of which go to the temple, and others to the cheek. The temporal branches are commonly two or three in number; they leave filaments with the parotid gland, mount over the zygoma, and are distributed to the anterior auris muscle, to the outer portion of the orbicularis palpebrarum, and to the integuments of the temple; they anastomose in their distribution with each other, with the superficial and deep temporal branches of the inferior maxillary nerve, and with the frontal and lachrymal branches of the ophthalmic. The malar branches are primitively, also, two or three in number: they cross the malar bone, dividing, subdividing, and anastomosing again, and are spent upon the integuments and muscles of this part of the face. They also anastomose with fila-

ments of the lachrymal nerve, and with those of the infra-orbitar nerve.

The Buccal Branches are three in number, sometimes two only, and pass across the masseter muscle under the skin. The superior anastomoses with the temporo-facial, and the inferior with the cervico-facial. The buccal branches supply the skin and muscles of the face intermediate to the eye and to the lower lip. The numerous filaments into which they divide anastomose frequently with each other, and with the branches of the fifth pair, which appear about the same parts, as the external and internal nasal nerve, the infra-orbitar, and so on. The middle buccal is parallel with the duct of the parotid gland, and adheres to it.

The Cervico-Facial Branch descends in the substance of the parotid gland, behind the ramus of the lower jaw; when it reaches the angle of the latter, it goes obliquely forwards, beneath the platysma myoides muscle. Though it sends off many fasciculi, they may be referred to two divisions, a superior and an inferior. The first crosses the inferior part of the masseter muscle, and may be traced, in its numerous distribution of filaments, to the integuments and muscles lying upon the body of the lower jaw. These filaments anastomose with each other, and with the mental branches of the inferior dental nerve. The inferior division supplies the skin and the platysma myoides muscle on the upper part of the neck, along the base of the lower jaw. Its filaments are joined by several coming from the anterior fasciculus of the third cervical nerve.

The anastomoses of the facial nerve, derived from its own branches and from those of the trigeminus, which reach the face, are entirely too numerous for a detailed description of them; it, indeed, appears unnecessary to extend the latter beyond a certain point. One of the most satisfactory accounts has been published by Meckel.[1]

SECT. VIII.—NERVUS HYPOGLOSSUS.

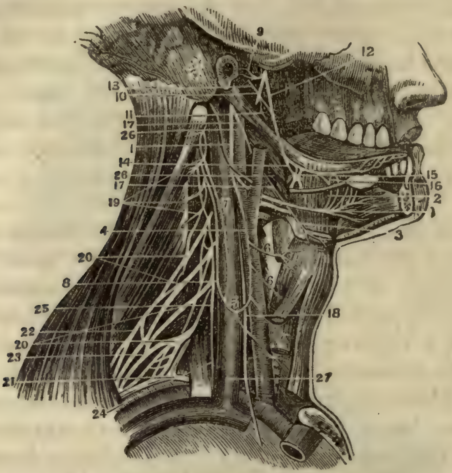
The Hypoglossal Nerve (*nervus hypoglossus*, *lingualis*), having arisen from the medulla oblongata, and escaped from the cranium through the anterior condyloid foramen, adheres closely for an inch to the pneumogastric nerve. It descends between the external carotid artery and the internal jugular vein, the latter being behind the other; and then winds over the carotid, externally, just below the origin of the occipital artery. It is there covered by the posterior belly of the digastricus and by the stylo-hyoideus. It then passes forwards beneath the external jugular vein, and lower down somewhat than the tendon of the digastric muscle, and, finally, ascends to the tongue, being covered or concealed by the mylo-hyoideus muscle. The nerve in this course, from the external carotid to the tongue, forms a remarkable curve, the convexity of which is downwards.

The Hypoglossal, while adhering to the pneumogastric, commonly

[1] J. F. Meckel, de Nervis Faciei, Mém. de l'Acad. des Sc. de Berlin, 1751, Caldani, Tab. 247.

leaves a few filaments with it. As it crosses the external carotid, it detaches a large branch, the Ramus Descendens Noni, which goes

Fig. 307.



The course and distribution of the Hypoglossal or Ninth Pair of Nerves. The deep-seated nerves of the neck are also seen.—1. The hypoglossal nerve. 2. Branches communicating with the gustatory nerve. 3. A branch to the hyoid muscles. 4. The descendens noni nerve. 5. The loop formed with the branches from the cervical nerves. 6. Branches to the external muscles of the larynx. 7. A filament from the second cervical nerve; and 8. A filament from the third cervical, uniting to form the communicating branch with the loop from the descendens noni. 9. An auricular branch. 10. The inferior dental nerve. 11. Its mylo-hyoidean branch. 12. The gustatory nerve. 13. The chorda tympani passing to the gustatory nerve. 14. The chorda tympani from the gustatory nerve to the submaxillary ganglion. 15. The submaxillary ganglion. 16. Filaments of communication with the lingual nerve. 17. The glosso-pharyngeal nerve. 18. The pneumogastric or par vagum nerve. 19. The three upper cervical nerves. 20. The four inferior cervical nerves. 21. The first dorsal nerve. 22, 23. The axillary plexus. 24, 25. The phrenic nerve. 26. The carotid artery. 27. The internal jugular vein.

down the neck, along the sheath of the carotid artery and the internal jugular vein, in front of the latter.

The Ramus Descendens has been beautifully figured by Scarpa, in his Plates of the Nerves. According to him, when it has got about half way down the neck, but still resting on the sheath of the vessels, it detaches, in front, two filaments, which, after the course of an inch forwards, unite, and then separate again to be distributed to the upper end of the omo-hyoid and sterno-hyoid muscles. The descendens noni then forms, an inch lower down, a small gangliform plexus, resting upon the sheath of the great vessels of the neck, under the omo-hyoid muscle. This plexus is joined by two fasciculi, which descend from the first and second cervical nerves; and from it proceed, downwards and backwards, two filaments, which join the phrenic nerve; also, one, to the lower part of the omo-hyoid muscle; and three or more, which are divided and distributed upon the sterno-hyoid and thyroid muscles, and upon the muscles of the larynx. Meckel states that some of these ramifications, on the left side principally, penetrate to the thorax, and reach the pericardium.

The hypoglossal nerve, having sent off the ramus descendens, reaches the external face of the hyoglossus muscle, and is there concealed by

the mylo-hyoideus; at this spot it gives filaments to the muscles of the larynx, to the hyoglossus, genio-hyoideus, and genio-hyoglossus. These filaments anastomose frequently with each other, and in two or three places at the anterior part of the tongue with the lingual branch of the nervus trigeminus. After these branches are given off, the trunk of the hypoglossal nerve penetrates into the substance of the genio-hyoglossus muscle, and extends itself near its fellow, and not far from the middle line of the tongue to the point of the latter. It first distributes filaments near the posterior part of the tongue, and then, successively, as far as its anterior extremity. They cannot be traced to the papillæ, but are lost upon the muscular structure.

It is a general opinion among anatomists that the hypoglossal nerve is only intended to excite the muscular movements of the tongue. The opinion is founded upon the circumstance of its filaments not reaching the papillæ, whereas those of the lingual branch of the trigeminus do. Colombo narrates a case, in which there was a congenital privation of taste, where the lingual branch of the trigeminus was distributed upon the occiput instead of upon the tongue, which goes far to prove the difference of function in the two nerves.

SECT. IX.—NERVUS ACCESSORIUS.

The Spinal Accessory Nerve (*nervus accessorius Willisii*), having arisen, as described, from the cervical medulla and the medulla oblongata, is directed outwards to the posterior foramen lacerum, in company with the pneumogastric or par vagum. Sometimes it is separated from it, in its passage through the base of the cranium, by a thin partition of dura mater; on other occasions merely by a fold of the tunica arachnoidea: but at the inferior part of this foramen it adheres closely to the par vagum, so that the two look like but one nerve.

Near its exit it is divided into two fasciculi. The internal gives off one or two filaments, which, joining a branch of the par vagum, forms the superior pharyngeal nerve; the internal branch then descends, and being divided into several branches, they successively join the upper part of the par vagum. The external fasciculus descends for two inches behind the internal jugular vein, being placed first of all between it and the occipital artery, but subsequently between the vein and the sterno-mastoid muscle. It then pierces this muscle about one-third of the length of the latter from its superior extremity, and leaves filaments in it which anastomose with some from the third cervical nerve. In continuing its descent, it is reinforced, and augmented considerably in volume, by branches from the second and the third cervical. Having reached the anterior margin of the trapezius muscle, it then distributes itself to the latter by internal and by external branches.

The spinal accessory and the par vagum are compared by Goerres[1] to the anterior and posterior roots of a spinal nerve. The enlargement of the vagum in the foramen lacerum, being considered ganglionic, is in favor of the analogy.

[1] Müller, p. 658.

SECT. X.—NERVUS GLOSSO-PHARYNGEUS.

The Glosso-Pharyngeal Nerve (*nervus glosso-pharyngeus*), though commonly considered as distinct from the pneumogastric, has so many connections with it, both at its root, in its course through the posterior foramen lacerum, and in its distribution, that it seems like a part or branch of the same. Shortly after it enters the canal in the dura mater, the Ganglion of Ehrenritter (*ganglion jugulare*), one-half of a line long, is formed upon some of its fibres. Having proceeded a little, the Ganglion of Andersech (*ganglion petrosum*, *neuronodon petrosum*), three lines long, is formed upon its entire trunk. This ganglion is in a little excavation (*vallecula*) of the petrous bone. The ganglions are so close that they have sometimes been mistaken for one only. The lower always has, according to Valentin, ganglion globules in it. They are both formed while the glosso-pharyngeal is in the posterior foramen lacerum. From the Ganglion Petrosum proceeds a branch, Jacobson's Nerve (*nervus tympanicus*), which is conducted to the tympanum by a special canal. In the tympanum being united with a filament of the sympathetic from the carotid canal, there proceeds from this junction the tympanic plexus, which sends filaments to the lining membrane of the tympanum and of the Eustachian tube, to the fenestra rotunda and to the fenestra ovalis.

The nervus tympanicus sends also, through the petrous bone, a filament to the sympathetic in the carotid canal, another to join the superficial petrous at the hiatus Fallopii or Vidian foramen, and a third, the small superficial petrosal nerve, to join with it the otic ganglion. The filament to the sympathetic is the anastomosis of Jacobson, of Copenhagen, as described in the account of the Vidian Nerve.[1] The ganglion also gives off other filaments, which join the pneumogastric nerve, the accessory, the facial, and the sympathetic.

On issuing from the posterior foramen lacerum, the glosso-pharyngeal is separated from the pneumogastric by the internal jugular vein. It is then directed downwards and forwards between the internal carotid and the stylo-pharyngeus muscle, afterwards between the latter and the styloglossus; it follows the direction of the latter to the side of the root of the tongue.

In this course it sends off many filaments. Shortly after leaving the cranium, it detaches one backwards to the digastric branch of the facial, and another to the pneumogastric. It then sends off two filaments, which descend along the internal and common carotid, and are divided into several branches; some of which anastomose with the pharyngeal branch of the pneumogastric; others descend on the common carotid with filaments from the pharyngeal branch, and being joined by two or three small twigs from the superior cervical ganglion, they reach the lower part of the neck, and concur in the forming of the superficial cardiac nerve. Farther down, after the origin of these branches, the glosso-pharyngeal detaches two or three filaments to the stylo-pharyngeus muscle, as well as some to the upper and middle constrictors of the pharynx, to the pharyngeal plexus of the sympathetic

[1] See Nerves of Organ of Hearing.

and pneumogastric, and to the posterior lateral and superficial part of the tongue.

The glosso-pharyngeal nerve having got between the stylo- and hyo-glossus muscles, is placed intermediately to the lingual branch of the fifth pair and the hypoglossal nerve. Some of its branches then go to the integuments of the base of the tongue, to its mucous glands, large papillæ, and may be traced to the mucous membrane of the soft palate, to the tonsil gland, and to the covering membrane of the epiglottis. Others go into the muscles of the tongue, and others may be traced along the external margin of the tongue, beneath its mucous membrane for some distance. Scarpa has delineated a remarkable plexus, which he denominates Circulus Tonsillaris Andersechii or Anastomosis Plexuosa, formed by these several filaments and by branches of the lingual, on the side of the root of the tongue, at the base of the tonsil gland.

SECT. XI.—NERVUS PNEUMOGASTRICUS.

The Pneumogastric Nerve (*nervus pneumogastricus*, *vagus*, *par octavum*, *decimum of Andersech*), in passing through the posterior foramen lacerum, forms a small ganglion, the Jugular (*ganglion superius nervi vagi*), upon its fasciculi. At its exit from the cranium through the posterior foramen lacerum, in front of the internal jugular vein, it is resolved into a plexus or ganglion (*plexus gangliformis*, *ganglion inferius nervi vagi*), is closely united to the hypoglossal, glosso-pharyngeal, and accessory nerves, by compact cellular substance. The superior ganglion is two lines in diameter, circular, and connects by filaments with contiguous nerves as the facial,[1] the petrous ganglion of the glosso-pharyngeal, the spinal accessory and the sympathetic.

The lower ganglion is outside of the skull, cylindroid, and about ten lines in length. All the fibres of the nerve do not enter it, to wit, the branch from the spinal accessory. It communicates with the sympathetic; the spinal accessory; the hypoglossal; the spinal and the sympathetic nerves. The pneumogastric is first placed in front of the hypoglossal nerve, but, in a short space, gets behind it, and becomes separated from the glosso-pharyngeal by the internal jugular vein. Opposite the transverse process of the atlas, it leaves the hypoglossal nerve, and assumes a position between the internal carotid and the internal jugular, on the vertebral side of these vessels, and is enveloped in their sheath of dense cellular substance. It maintains this relative position along the common carotid to the root of the neck.

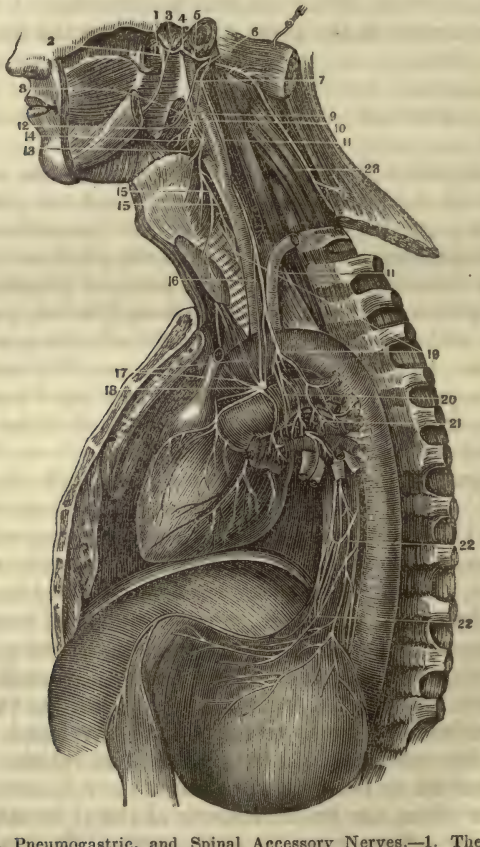
At the latter place, the pneumogastric of the right side goes in front of the subclavian artery, near its root; and on the left side it crosses the root of the left subclavian artery, and then the arch of the aorta to the left of the origin of the left carotid. In getting fairly into the cavity of the thorax, it is directed backwards and downwards from these points towards the posterior face of the bronchus, between it and the pleura. It then abandons the bronchus, and applies itself to the œso-

[1] This branch joins the facial in the aqueduct of Fallopius, and then goes to the pinna of the external ear, along with the posterior auricular.

phagus, and follows it through the diaphragm to the stomach. The nerve of the left side, in its course along the œsophagus, is on the front surface of the latter, and the nerve of the right side on its posterior surface.

The pneumogastric anastomoses with the accessory while passing through the foramen lacerum posterius. Somewhat lower down, it makes the anastomoses with the glosso-pharyngeal and with the superior cervical ganglion of the sympathetic. The branches which it afterwards sends off, go to the neck, to the viscera of the thorax, and to those of the abdomen, after the following manner:—

Fig. 308.



Glosso-Pharyngeal, Pneumogastric, and Spinal Accessory Nerves.—1. The inferior maxillary nerve. 2. The gustatory nerve. 3. The chorda tympani. 4. The superficial temporal nerve. 5. Communication of the facial nerve with the superficial temporal. 6. The facial nerve coming out of the stylo-mastoid foramen. 7. The glosso-pharyngeal nerve. 8. Branches to the pharyngeal muscles. 9. The pharyngeal branch of the pneumogastric nerve descending to form the pharyngeal plexus. 10. Branches of the glosso-pharyngeal to the pharyngeal plexus. 11. The pneumogastric nerve. 12. The pharyngeal plexus. 13. The superior laryngeal branch. 14. Branches to the pharyngeal plexus. 15, 15. Communication of the superior and inferior laryngeal nerves. 16. Cardiac branches. 17. Cardiac branches from the right pneumogastric nerve. 18. Cardiac plexus. 19. The recurrent or inferior laryngeal nerve. 20. Branches sent from the curve of the recurrent nerve to the pulmonary plexus. 21. The anterior pulmonary plexus. 22, 22. The œsophageal nerves.

A. Cervical Branches. The Superior Pharyngeal Nerve (*ramus pharyngeus*) arises just below the preceding anastomosis. It is directed

downwards on the internal face of the internal carotid, and having sent an anastomotic filament to the glosso-pharyngeal nerve, it forms on the middle constrictor of the pharynx the pharyngeal plexus, which is reinforced by filaments from the superior cervical ganglion of the sympathetic, from the glosso-pharyngeal, and from the superior laryngeal nerve. The filaments departing from this plexus are spent principally upon the middle constrictor, but a few of them also go to the superior constrictor; and others, descending along the primitive carotid, anastomose with ramifications from the glosso-pharyngeal, and from the superficial cardiac nerve.

A filament, called the Inferior Pharyngeal, sometimes proceeds from the pneumogastric a little below the other, and also is spent upon the pharynx.

The pneumogastric, at the place where it detaches these pharyngeal branches, or a little above them, becomes softened in its texture, enlarges somewhat, and has the fasciculi which compose it moderately separated by a sort of red gelatinous substance interposed between them. This portion is its *gangliform plexus*, as mentioned.

The Superior Laryngeal Nerve (*nervus laryngeus superior*) arises from the gangliform plexus. It descends between the internal carotid and the superior cervical ganglion, anastomosing on the way with the latter, with the pharyngeal plexus, and the hypoglossal nerve; it then divides into an *external* and an *internal* laryngeal branch. The former sends its filaments to the muscles situated on the fore part of the thyroid cartilage; to the thyroid gland; and some of them penetrate through the middle crico-thyroid ligament to the lining membrane of the larynx. The internal laryngeal branch is placed above the other, and is considerably larger; it is directed towards the middle thyreo-hyoid ligament, which it penetrates and then begins to ramify. Some of the branches go to the epiglottis cartilage, its covering membrane, and the adjacent portion of the lining membrane of the pharynx. Other branches are distributed to the small muscles which move the arytenoid cartilages, and to the lining membrane of the larynx. The filaments which go to the epiglottis have an arrangement indicated by Bichat, that of going into the foramina which perforate it, but they cannot be traced farther.

The pneumogastric afterwards does not send off any regular branches till it reaches the lower part of the neck. It then detaches two or three filaments (*rami cardiaci*), which, on the right side, have their roots about an inch above the subclavian artery, and on the left side an inch lower down. On the right side, they descend along the subclavian and the arteria innominata, and on the left along the left carotid; they reach the arch of the aorta, and in their course, as well as there, anastomose very freely with the superficial cardiac nerve. The rami cardiaci are frequently more abundant on the right side than on the left.

The Inferior Laryngeal Nerve (*nervus laryngeus inferior*, *recurrens*) is a considerable branch of the pneumogastric, which comes off next to the cardiac branches. On the right side it arises immediately after the trunk has passed between the subclavian artery and the subclavian vein. It then winds around the subclavian artery so as to retain the latter in its loop; having thus got behind the artery, it then ascends towards the

larynx, on the side of the trachea, covered by the common carotid, and by the inferior thyroid artery.

In this course the inferior laryngeal nerve detaches the following branches: 1. From the convexity of its loop it sends filaments to the assistance of the cardiac branches just spoken of, arising from the pneumogastric, and to those coming from the inferior cervical ganglion of the sympathetic. 2. It detaches the pulmonary branches, the origin of which is complicated with the plexus of nerves existing about their roots; these descend in front of the trachea, reach the pulmonary artery, and follow its ramifications into the lungs; some of the filaments, however, go to the cardiac plexus. 3. The inferior laryngeal then sends many filaments to the œsophagus. 4. Branches which go to the inferior part of the thyroid gland. 5. Filaments to the trachea, some of which penetrate the membrane on its posterior part, others go between the cartilages; they are then distributed to the lining membrane and to the mucous glands of the part. 6. The inferior laryngeal nerve is then distributed in branches to the inferior constrictor of the pharynx and its lining membrane, but the most of its terminating filaments penetrate to the larynx, between the thyroid and the cricoid cartilage, and are lost upon the lining membrane of the larynx, and upon the small muscles which move the arytenoid cartilages. These terminating filaments anastomose with such as come from the superior laryngeal nerve.

The recurrent of the left side forms a much larger loop than the other, and arises lower down, inasmuch as it has to wind around the arch of the aorta, at the origin of the left subclavian artery. With some inconsiderable exceptions, its course and distribution afterwards are precisely the same with those of the nerve of the right side.

It is stated by some anatomists that the distribution of the inferior laryngeal nerve to the larynx is confined to the thyreo-arytenoid, and to the posterior and lateral crico-arytenoid muscles. Mr. G. Rainy states, in the *London Medical Gazette*, that he has repeatedly traced its filaments, also, to the transverse and the oblique arytenoid.[1]

Mr. Hilton[2] found, in his dissections, that the superior laryngeal nerve, excepting its external laryngeal branch and a filament to the arytenoid muscles, went wholly to the mucous membrane of the larynx, and not to other parts of it; the conclusion, hence, is that it is a pure nerve of sensation. The distribution of the inferior laryngeal, on the contrary, to all the muscles, is a proof of being the one of motion. The experiments of Dr. J. Reid appear to have satisfied the physiologists of England that the superior laryngeal is the excitor or afferent nerve, while the inferior laryngeal is the motor.[3]

B. The Thoracic Branches of the pneumogastric are as follow: The Inferior tracheal nerves come from it just below the recurrent: they are five or six in number; some of them go in front of the trachea and bronchus, and others behind them. They are complicated by anastomoses with the branches of the recurrent nerve, and with those of the

[1] Am. Med. Journ. vol. iv. p. 198.
[2] Guy's Hospital Reports, vol. ii.
[3] Carpenter, loc. cit. p. 289.

inferior cervical ganglion, and form a small intertexture denominated the *anterior pulmonary plexus*, which lies upon the front of the root of the lung, and has its filaments following the branches of the pulmonary artery through the lung. The posterior filaments supply the structure of the bronchus by penetrating it, and some of them go to join the posterior pulmonary plexus.

As the pneumogastric gets behind the trachea and the bronchus, it is sensibly enlarged and somewhat flattened, the cohesion of its fasciculi being somewhat looser. Several filaments depart there from it, which form an intertexture with each other; some of them pass inwards, to be distributed on the bronchus, trachea, and œsophagus. Others, which are given off as the nerve lies upon the posterior face of the root of the lung, amounting to six or seven in number, but being of various sizes, run transversely outwards, and form an intertexture with one another. The latter are joined by filaments from the inferior cervical and the first dorsal ganglion of the sympathetic, and thus constitute the *posterior pulmonary plexus*. The filaments from this plexus follow the distribution of the bronchus, and, according to Bichat, are all destined to the mucous membrane and the mucous glands of the lung; as they may be traced piercing successively the ramifications of the bronchus, in order to reach its lining membrane.

On the right side, the par vagum, while furnishing the pulmonary plexus, and for some distance lower down, is divided into from four to six considerable fasciculi, which form with each other a plexus or series of anastomoses, having very large meshes, and from which proceed many filaments to the œsophagus. Afterwards the fasciculi are assembled into a single cord, which proceeds, on the posterior face of the œsophagus, along with it into the abdomen.

On the left side, the par vagum, after forming the posterior pulmonary plexus, is split into two or three fasciculi; which likewise furnish branches to the œsophagus, and unite to form a single cord, which proceeds on the front surface of the œsophagus, along with it into the abdomen.

The two nerves, while descending in this way, send frequent filaments to each other, and to the œsophagus.

C. In the Abdomen the par vagum is distributed as follows: Filaments are sent from each nerve, and which form a plexus around the cardiac orifice of the stomach. The right nerve is then divided into many branches; some are distributed on the posterior face of the stomach, others go along the lesser curvature of this viscus, and reach thereby the pylorus, where they anastomose with filaments from the left nerve, and from the gastric plexus of the sympathetic; others go behind the stomach to join the solar plexus, and are blended with the latter in its distribution to the liver, vena portarum, duodenum, and pancreas. The left par vagum, being placed in front of the cardia, is resolved into several radiating filaments or fasciculi, some of which supply the anterior face of the stomach; others go along its lesser curvature to the pylorus, to anastomose with the right nerve and the gastric branches of the sympathetic, and are finally blended, after the same manner as the preceding, with the solar plexus.

CHAPTER II.

OF THE SYMPATHETIC NERVE.[1]

The Sympathetic Nerve (*nervus sympatheticus magnus, intercostalis maximus, gangliosus*) differs, in a great number of respects, from every other nerve of the body; and if we were actuated only by its peculiarities, with Bichat, Meckel, and others, we might, with great propriety, set it apart as something having a claim to an insulated account and location. The dissection of it, however, is so much blended with that of the par vagum, that the descriptions of the two go best hand in hand, and are, therefore, most conveniently studied together.

This nerve consists in a series or chain of ganglions, extending from the base of the cranium, or rather from the anterior communicating artery at the ganglion of Ribes, to the lower end of the spinal column, where it forms the coccygeal ganglion. The ganglions are placed generally near or upon the lateral part of the bodies of the vertebræ, are united to each other by intermediate nervous cords, and send off continually filaments, pre-vertebral plexuses, to the adjacent organs. With the exception of the neck, there is a ganglion for each intervertebral space both of the true vertebræ and sacrum. Besides these ganglions, there are others which are situated around the trunks of some of the large vessels of the abdomen.[2]

The superior extremity of the sympathetic nerve, opposite to the transverse process of the second cervical vertebra, and behind the internal carotid artery, forms a ganglion, which, for clear description, may be considered as the first of the series, though there are several smaller ganglia in the head above it, as will be presently explained. This ganglion is the Superior Cervical.[3]

The nervus motor externus oculi, in passing through the cavernous sinus, and the Vidian nerve, in passing by the point of the petrous bone, both send a filament downwards through the carotid canal; which two filaments unite to form a single cord, that runs into the superior extremity of this ganglion. The filament from the Vidian nerve is, as mentioned in the account of the superior maxillary, the deep petrous nerve. The common view taken by anatomists of this nervous connection is, that it is the beginning of the sympathetic, though, by

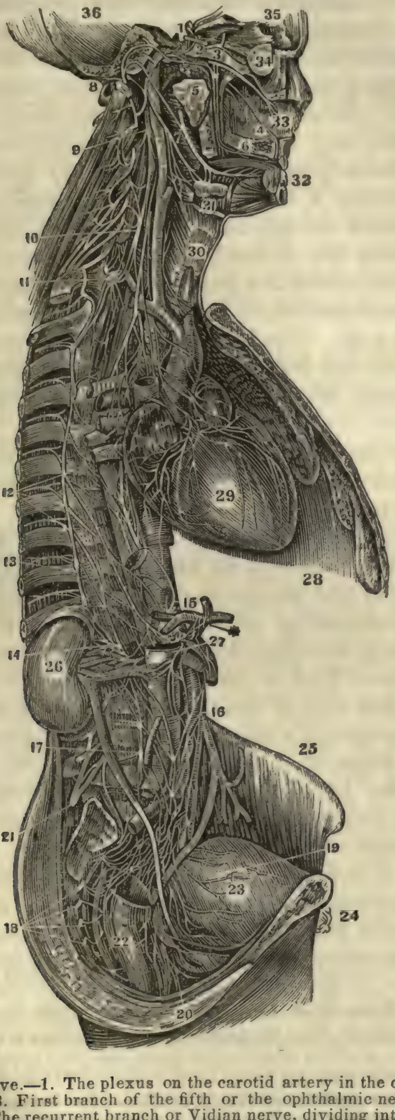
[1] Anton. Scarpa, Tabul. Neurolog.

[2] In the ganglia of the sympathetic, it is doubted whether the separate nervous filaments really unite, or keep distinct.

[3] Origin in anatomy is a conventional term, and means in many instances rather the more convenient beginning of a description than a germinal act. In this view the ganglion of Ribes is the origin or upper terminus of the sympathetic, as the coccygeal ganglion or anastomosis in front of the os coccygis is the inferior terminus. The part of the nerve which, in point of value, exceeds all others, would probably be found in the semilunar ganglion and the solar plexus coming from it, and which might therefore be assumed as the origin really.

Bichat, it is described as the termination, or one of its extremities. The distinction, though important physiologically, is less so when the object is simply to describe the course and anatomical relations of this

Fig. 309.



Great Sympathetic Nerve.—1. The plexus on the carotid artery in the carotid foramen. 2. Sixth nerve (motor externus). 3. First branch of the fifth or the ophthalmic nerve. 4. Incisive foramen, naso-palatine nerve. 5. The recurrent branch or Vidian nerve, dividing into the carotid and petrosal branches. 6. Palatine nerve. 7. The lingual nerve joined by the chorda tympani. 8. The portio dura of the seventh pair or the facial nerve. 9. The superior cervical ganglion. 10. The middle cervical ganglion. 11. The inferior cervical ganglion. 12. The roots of the great splanchnic nerve arising from the dorsal ganglia. 13. The lesser splanchnic nerve. 14. The renal plexus. 15. The solar plexus. 16. The mesenteric plexus. 17. The lumbar ganglia. 18. The sacral ganglia. 19. The vesical plexus. 20. The rectal plexus. 21. The lumbar plexus (cerebro-spinal system). 22. The rectum. 23. The bladder. 24. The pubes. 25. The crest of the ilium. 26. The kidney. 27. The aorta. 28. The diaphragm. 29. The heart, with its cardiac plexus. 30. The larynx. 31. The submaxillary gland. 32. The incisor teeth. 33. Nasal septum. 34. Globe of the eye. 35, 36. Cavity of the cranium.

nerve, as they may be equally understood by either mode of description.

The Deep petrous most frequently forms, on the external face of the internal carotid, in the cavernous sinus, or more generally in the carotid canal, a ganglion (*ganglion cavernosum, caroticum*), discovered by Laumonier. Some anatomists consider this ganglion to arise, by one or more filaments, from the motor externus. This ganglion, to say the most of it, is an elongated flattened enlargement of the trunk of the deep petrous, in many subjects, if not in most, scarcely meriting the name of ganglion.[1] From the ganglion cavernosum, it has been ascertained that filaments may be traced to the ganglion of Gasser (*plexus gangliformis*), of the trigeminus, to the pituitary gland, to the infundibulum; and, moreover, a fasciculus which, according to H. Cloquet, forms a plexus around the ophthalmic artery, and may be traced along all its branches, even the central artery of the retina. This plexus anastomoses with the lenticular ganglion, and consequently establishes a direct nervous communication between the sympathetic and the first branch of the fifth pair. The knowledge of this connection has caused anatomists to locate the lenticular ganglion and the ciliary nerves in the ganglionic system of the sympathetic, as forming a part of the latter.

The name Cavernous plexus is given to the arrangements of the sympathetic in the cavernous sinus and that of the Carotid plexus for the portion in the carotid canal.[2]

From the ganglion of Laumonier may also be traced a filament, which, attending the carotid in its ascent by the sella turcica, follows the anterior artery of the brain, or arteria callosa; and, having reached the anterior communicating artery, it runs into a ganglion on the middle of this artery, the ganglion being common to it and the nerve of the opposite side. This is the Ganglion of Ribes,[3] and establishes for the extreme upper end of the two sympathetics an anastomosis, or connection, on the same principle that the two lower ends communicate by anastomosis in front of the os coccygis.

The Sympathetic, in descending the neck, is placed behind the carotid artery and internal jugular vein. It is commonly said to be enclosed in the sheath of these great vessels, but the statement is loose and inaccurate, as it is fastened to the front surface of the longus colli muscle by cellular substance distinct from the sheath, as may be manifested by pushing a knife handle between them and raising up the sheath. The cord which comes down from the carotid canal is close to the pneu-

[1] M. Lobstein, in his Essay on the Sympathetic (Paris, 1823), a work of much merit, has also attributed this ganglion to the deep petrous nerve, in which I thought for many years he was mistaken, though renewed observations have now convinced me of his correctness.

[2] Filaments of communication are found here with most of the contiguous nerves, as the third, fourth, fifth, and sixth, under some mode or other. For instance, with the third in the cavernous sinus and through the lenticular ganglion, as stated; with the fourth in the nerve sent by the latter to the tentorium; with the ophthalmic division of the fifth in the cavernous sinus; with the sixth by the origin stated; with the superior maxillary, through the spheno-palatine ganglion; and with the inferior maxillary through the otic ganglion.

[3] The real existence of the Ganglion of Ribes is rather unsettled: for its description, see Mém. de la Société Méd. d'Emulation, tom. viii. p. 606. I have often looked for it unsuccessfully. The best English anatomists are in the same doubt. See Sharpey and Quain, vol. ii. p. 349.

mogastric and hypoglossal nerves. Having formed the first cervical ganglion, it descends as mentioned; and, opposite to the space between the fifth and sixth cervical vertebræ, it is again enlarged into the Middle Cervical Ganglion, which is much smaller and more irregular than the first. The sympathetic is then traced with some difficulty, in consequence of the numerous branches coming from it; but, with attention, a trunk may be found as the continuation of it. This trunk passes to the interval between the head of the first rib and the transverse process of the last cervical vertebra, and there enlarges into another ganglion, called Inferior Cervical, or First Dorsal.

To understand well the connections of the sympathetic in the neck, each of the cervical ganglions must be studied particularly.

1. The *Superior Cervical Ganglion* varies considerably in its extent; commencing very generally opposite to the second cervical vertebra, it is sometimes elongated to the lower part of the third, and even of the fourth. In cases of unusual elongation, it is smaller than in others.

It sends off, from its external margin, several filaments, about four, which cross the anterior face of the rectus anticus major muscle, and terminate by anastomosing with the anterior fasciculus of the occipital nerve and of the first three cervical; when the ganglion is short, the two lower filaments come from the sympathetic below it, instead of from the ganglion.

Several filaments also proceed from this ganglion to the contiguous muscles on the vertebral column, to the pharynx, to the larynx, and to the thyroid gland.

This ganglion also sends off what are called its Anterior branches, which are peculiar for their reddish color and for their softness; the latter quality has obtained for them the name of Nervi Molles. They may be referred, by their position, to three orders. The superior ascend to anastomose with the pneumogastric, hypoglossal, and facial nerves, near their exit from the cranium. The middle are two or three in number, but immediately divide into many filaments, forming the carotid plexus by assistance from the pneumogastric, glosso-pharyngeal, and facial nerves. Some of the branches of this plexus descend behind the primitive carotid at the place of its bifurcation, and accompany it to its origin, continually interlacing with each other. Others surround, after the same manner, the external carotid, and subdivide into a plexus for each of its branches, so that very fine filaments may be traced along the superior thyroidal, the lingual, facial, occipital, and temporal arteries. These nerves are, for the most part, difficult to trace, from their extreme tenuity. The primitive branches, from which these plexuses come, are sometimes previously united into a small ganglion (*ganglion inter-caroticum*) in the angle between the Internal and External Carotid Artery, and other ganglions are also sometimes met with, which serve as a common centre to all these nervous radiations. The third order of anterior branches, amounting to from four to six, come either from the ganglion or from the sympathetic just below it.

The *Superior*, or the *Superficial Cardiac Nerve* is a cord formed from the last-named branches of the sympathetic, and it descends on

the external side of the primitive carotid, anastomosing with filaments from the pneumogastric and from the descendens noni. It gives small ramifications to the contiguous parts, as to the pharynx, œsophagus, the sterno-hyoid and thyroid muscles. It terminates in the lower part of the neck, by detaching anastomosing branches to the branches of the recurrent nerve: some of them also go along the inferior thyroid artery to the thyroid gland. What remains of it is lost in the middle cardiac nerve; for it cannot be traced, in an insulated and distinct manner, to the heart; from which cause its appellation is objectionable.

2. The *Middle Cervical Ganglion*, placed intermediately to the fifth and sixth cervical vertebræ, upon the longus colli muscle, is there concealed by the common carotid, the internal jugular vein, and the pneumogastric nerve. It is sometimes deficient: according to Meckel, in the proportion of once in three times. In my own dissections I have always found it, though under various circumstances of size and form. It is more flattened than the preceding, and never so long. Sometimes it is double. Like the preceding, it has a great many filaments attached to, or emanating from it.

The external filaments, amounting to about three in number, pass from it to the anterior fasciculi of the fourth, fifth, and sixth cervical nerves, between the origins of the scaleni muscles. Some of its filaments accompany the inferior thyroid artery, and, along with the superficial cardiac, form a plexus around it, which reaches to the thyroid gland.

The *Middle Cardiac Nerve* is formed by several of the anterior branches, collecting into a single cord. The latter descends along the external side of the primitive carotid, crosses on the right side of the body the root of the subclavian artery, and then, going along the posterior face of the arteria innominata, it gets between the aorta and the bifurcation of the trachea, where it is merged in the commencement of the cardiac plexus of nerves. On the left side, the middle cardiac nerve is formed by an assemblage of filaments from the middle and inferior cervical ganglia, which descend along the left subclavian artery to the aorta, and are joined, on the front of the latter, by the superficial cardiac nerve. On both sides, these cardiac nerves form intricate anastomoses with the pneumogastric nerve and its recurrent branch.

3. The *Inferior Cervical Ganglion*, situated, as mentioned, near the head of the first rib, like the others, is subject to variations in its form and size. Several filaments may be traced between it and the middle cervical ganglion. One penetrates into the canal of the transverse processes along with the vertebral artery, and, forming a plexus around it, may be traced distributing branches to the heads of the contiguous muscles as high up as the second cervical vertebra.

The external branches of the inferior cervical ganglion are numerous and small. Some of them anastomose with the anterior fasciculi of the two or three inferior cervical and the first dorsal nerve. Others form a plexus around the subclavian artery, and follow the latter, in its branches, to the upper extremity, to the shoulder, and to the neck.

The *Inferior Cardiac Nerve.* The anterior branches of the inferior cervical ganglion concur, after some anastomoses with each other, to form a single cord, the Inferior Cardiac Nerve, which goes, on the right side, along the arteria innominata, to be blended with the cardiac plexus. On the left side, it is not so distinct, but it is blended with the middle cardiac nerve, and forms its inferior root.

Of the Cardiac Plexus of the Sympathetic.

The Cardiac Plexus (*plexus cardiacus*) is situated between the arch of the aorta and the lower part of the trachea and the bronchia, and extends transversely from the division of the pulmonary artery to the commencement of the arteria innominata. It is formed, almost wholly, from the branches sent by the three cervical ganglia of the sympathetic of each side, and principally from that of the middle one, or the middle cardiac nerve. The filaments which come from the recurrent nerve and the par vagum are blended into the cardiac plexus in such a manner that they cannot be traced separately to the heart. It is worthy of remark that the three cardiac nerves of the right side are more constantly found than the same number on the left, in consequence of the lower one of the latter soon merging itself, after its origin, into the middle cardiac nerve of that side.

The cardiac plexus is formed by the common assemblage of the nerves from the two sides of the neck, and is therefore single. From this plexus arise all the nerves which go to the heart, so that in tracing them the distinction between right and left is confounded. Scarpa has pointed out, in this circumstance, an analogy between them and the nerves which supply the abdominal viscera.

In this plexus is found, but not invariably, the cardiac Ganglion or Ganglion of Wrisberg. Its size is uncertain; it is placed behind the aorta, to the right of the ligamentous remains of the ductus arteriosus. It receives the superior cardiac nerve of each side, and also a branch from the par vagum, and detaches numerous branches to the cardiac plexus. Other ganglionic bodies are sometimes found in the branches of the cardiac plexus.

The cardiac plexus is distinguished by the softness of its texture. For the purpose of description, its branches may be divided into Anterior, Posterior, and Inferior.

The *Anterior Branches*, making the superficial cardiac plexus, are but few. They are found on the front of the arch of the aorta. One of them crosses it to the right of the arteria innominata; others cross it from the foot of the left carotid and subclavian, downwards. In both cases, several of the terminating filaments run into the anterior coronary plexus.[1]

The *Posterior Branches* are more numerous, but run only a short

[1] Scarpa.

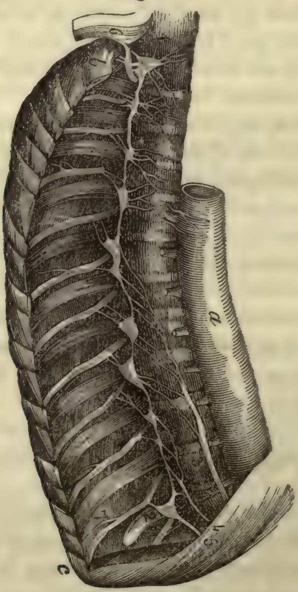
course, when they are much blended into the anterior pulmonary plexus formed by the par vagum.

The *Inferior Branches*, constituting the deep cardiac plexus of Scarpa, are the largest and the most abundant. Some of them follow the pulmonary artery until its entrance into the lungs; others are distributed upon the pulmonary veins; but the greater number of them are arranged into two plexuses called Coronary, from their observing the course of the coronary arteries. The posterior or Left coronary plexus is larger than the other. It reaches the base of the heart, along the pulmonary artery, and has its filaments distributed principally to the left auricle and left ventricle, observing the course of the left coronary artery and of its branches. The anterior or Right coronary plexus gets in front of the heart, between the aorta and the pulmonary artery. It anastomoses freely at its superior part with the other, and is then distributed to the right auricle and ventricle, along the course of the right coronary artery and of its branches.

Of the Thoracic Ganglia of the Sympathetic.

These ganglia are twelve in number, and are placed on or near the heads of the ribs, at the commencement of each intercostal space, and are only covered by the pleura. Their shape is irregular, and they differ also in size, being always smaller than the cervical ganglia. The

Fig. 310.



A representation of the Ganglia of the Sympathetic in the Chest, reduced from Mr. Swan's work.—*a.* Aorta. *b.* First rib. *c.* Eleventh rib. 1. First thoracic ganglion. 2. Last thoracic ganglion. 3. Large splanchnic nerve. 4. Small splanchnic nerve. 5. Posterior renal nerve. 6. Part of the axillary plexus.

cord of the sympathetic is continued, successively, from one ganglion to another, so that they form a complete chain by their connection.

From each ganglion there proceed one or more external branches, which go outwards to anastomose with the subcostal nerve of the corresponding part. Each ganglion also detaches one or more internal branches or filaments to the adjacent parts lying on the vertebral column; some go to the cellular substance, others to the longus colli muscle, others to the aorta, others to the cardiac and to the pulmonary plexus. Among these internal branches there are several which concur to form the Splanchnic Nerves, of which there are two—the Great and the Small.

The *Great Splanchnic Nerve* arises by filaments, from the sixth to the ninth or tenth thoracic ganglia, inclusively; one or more filaments coming from each ganglion.[1] They are directed downwards and forwards on the sides of the dorsal vertebræ, covered by the pleura, and unite, successively, into a trunk about the eleventh dorsal vertebra. This trunk penetrates into the cavity of the abdomen, between the middle and the internal part of the lesser muscle of the diaphragm, or by the opening for the aorta.

Having got into the abdomen, the great splanchnic divides into several fasciculi, which, diverging from each other, are concealed on the right side by the liver, and on the left by the stomach. On each side of the aorta there is a large ganglion formed by an assemblage of several smaller ones; it is called the Semilunar. In it terminate, for the most part, these fasciculi; some of them, however, go immediately into the solar plexus, which emanates from the semilunar ganglion.

The *Small Splanchnic Nerve* is derived, by filaments, from the tenth and the eleventh thoracic ganglia. Having united, they penetrate the crus of the diaphragm, and, reaching the abdomen, the trunk is divided into two branches, of which the uppermost ascends to join the great splanchnic before its division, and the lower descends to join the renal plexus.

Posterior Renal Nerves.—Besides these two splanchnic nerves, it frequently happens that there are others which come from the eleventh and twelfth thoracic ganglia, and from the communicating branch between the last thoracic and the first lumbar. They unite into a trunk which goes to the renal plexus, and have been called, by Walter, the Posterior Renal Nerves.

Of the Solar Plexus.

The Semilunar Ganglion, situated, as mentioned, on the side of the aorta, is somewhat semicircular or oval, and is about an inch long; its form, however, is much diversified in different subjects. The several ganglia of which it is composed are frequently fused into a single one. That of the right side is more voluminous than the other, and is placed between the ascending vena cava and the right crus of the

[1] It is asserted by Mr. Beck, an English anatomist, that with the use of acetic or diluted nitric acid he has traced contributions to this nerve as high as the first dorsal ganglion. Phil. Trans. 1846.

diaphragm, somewhat above the right renal artery. That of the left is situated upon the left crus of the diaphragm, somewhat below the splenic artery. Between their inferior extremities, there are generally two or three smaller ganglia.

These several ganglia are united by numerous filaments, which send out many ramifications, and anastomose freely with each other.

The preceding arrangement may be considered as the root of the Solar Plexus, which extends from the cœliac artery to the lower margin of the emulgents, and as it is common to the ganglia of the two sides, it is an inch and a half or two inches wide. Bichat has very properly remarked that this plexus seems to exist for the aorta, as all the divisions which it sends out follow so exactly the branches of this artery that we are forced to adopt the latter as the basis of the description. The intertexture and the number of the branches emanating from the solar plexus are so complicated that a description of individual branches would be almost endless, as well as unintelligible; anatomists are, therefore, generally agreed to describe the plexus according to the order of the arteries which its detachments adhere to and surround.

1. The *Diaphragmatic Plexus* consists of a few filaments coming from the superior part of the solar, and following the course of the phrenic arteries. Some of them anastomose with the terminating filaments of the phrenic nerve, in the thickness of the diaphragm.

2. The *Plexus which surrounds the Cœliac Artery*, like it, is quickly disposed into three divisions, which follow the branches of this artery.

a. The *Superior Coronary Plexus* of the stomach is the smallest of the three. It attends the corresponding artery along the lesser curvature of the stomach to the pylorus, supplying the stomach continually with very fine filaments. In its course, it anastomoses with the par vagum, and sends filaments to the hepatic plexus.

b. The *Hepatic Plexus* is the largest of the three. It surrounds the hepatic artery and the vena portarum, and, in its course, detaches branches which go with the right gastro-epiploic artery to the great curvature of the stomach, and constitute the inferior coronary plexus. Branches are also sent to the pancreas and to the duodenum. The hepatic plexus then enters the transverse fissure of the liver, and its branches may be traced to the several lobes and to the gall-bladder.

c. The *Splenic Plexus* is but small, and surrounds the splenic artery. The few branches of which it is composed anastomose but rarely with each other. Some of them are distributed upon the pancreas, along with the pancreatic branches of the splenic artery; others go with the left gastro-epiploic artery to the left extremity and the greater curvature of the stomach; the remainder penetrate into the substance of the spleen, through its fissure, along with the branches of the splenic artery.

3. The *Superior Mesenteric Plexus* is derived from the solar, near

the superior mesenteric artery; it descends some short distance on the aorta, before it reaches the latter. It passes with the artery between the pancreas and the duodenum, and is then included between the two laminæ of the mesentery: it is there distributed, by very numerous filaments, along with the branches of the artery, to the whole of the small intestines, to the cœcum, and to the ascending and transverse colon.

4. The *Renal Plexus*, one on each side, is derived from the lower lateral part of the solar, and from the Posterior Renal Nerves. Two or three ganglia, on the root of the renal artery, contribute to it, and it is also reinforced by an addition from the lesser splanchnic nerve. The branches which form this plexus do not anastomose much till they get near the kidney; they then penetrate into its substance, through the fissure. Some filaments from this plexus go to the capsula renalis: others follow the course of the spermatic artery, and constitute the spermatic plexus which goes to the testicle in the male, and to the ovarium in the female.

5. The *Inferior Mesenteric Plexus* is a continuation of the solar on the anterior face of the abdominal aorta. It is much smaller than the superior mesenteric plexus, though it receives continually, in its descent, filaments from the lumbar ganglia of the sympathetic. It forms frequent anastomoses around the root of the inferior mesenteric artery, and near the superior strait of the pelvis is resolved into two columns of fibres. One column is distributed along with the artery to the rectum, to the sigmoid flexure of the colon, and to the left section of the latter, thereby anastomosing with the colic branches of the superior mesenteric plexus. The other column descends into the pelvis, in front of the sacrum, and contributes to form the hypogastric plexus, but several of its branches also follow the external and the internal iliac arteries.

Of the Lumbar Ganglia of the Sympathetic.

These ganglia are five in number, on either side, and are placed anteriorly on the sides of the bodies of the lumbar vertebræ, near the anterior margin of the psoas magnus muscle. Their form is irregular; they are smaller than the cervical ganglia, but larger than the dorsal.

The last thoracic ganglion is united to the first lumbar by a small branch, which may be considered as the continuation of the sympathetic. A deficiency of this branch has, however, been several times observed by anatomists; also a deficiency in the connecting nervous cord of the ganglia below. The ganglia themselves are inconstant in their number, being sometimes less than five; they vary likewise in their situation. It is to be understood, however, that in a majority of subjects, the sympathetic goes on uninterruptedly from one ganglion to another, sometimes by one branch; on other occasions, by two or three.

Each lumbar ganglion sends outwards one or more external branches, which, applying themselves to the body of the contiguous vertebra,

reach the corresponding intervertebral foramen of the loins, and join with the anterior branch of the corresponding lumbar nerve. Some of these external branches are spent upon the quadratus lumborum muscle.

Each lumbar ganglion, or the intermediate cord of the sympathetic, also detaches branches internally, which are very small, and more or less interwoven with each other. These branches get to the abdominal aorta, and, joining the inferior mesenteric plexus upon it, are distributed along with the latter.

Of the Sacral Ganglia of the Sympathetic.

There are generally three of these ganglia which may be readily found: sometimes four or five. They are situated in a line, on the anterior face of the sacrum, near the corresponding foramina for the transmission of the sacral nerves; and are united with each other by intermediate fibres, from one to three in number, which are the continuation of the sympathetic nerve. Bichat asserts that frequently the first of these ganglia is not united to the last of the lumbar by an intermediate nerve, so that there the continuity of the sympathetic is interrupted.

Each ganglion sends off, externally, one or more filaments, by which it is united to the corresponding sacral nerve; it also detaches filaments in this direction to the pyriformis and the levator ani muscles.

Each ganglion likewise detaches, from its internal margin, ramifications, which go obliquely downwards on the front of the sacrum, and anastomose with the corresponding filaments from the opposite side.

From these ganglia many branches pass forwards to the hypogastric plexus, which is formed by them, by the inferior mesenteric plexus, and by a great many filaments from the lower sacral nerves, principally the third. The plexus is distributed upon the rectum, the bladder, vesiculæ seminales, and prostate of the male; and, in place of the two latter in the female, upon the vagina and the uterus. The nerves of the uterus are said to have no change of size during pregnancy, and no change of position except from the enlargement of the organ.[1]

The last sacral ganglion detaches downwards one or more filaments, which lie upon the front of the os coccygis, and anastomose with the corresponding filaments from the other side, to form a sort of arch, the convexity of which is downwards. In the centre of this union is the coccygeal ganglion from which emanate filaments to the front of the os coccygis. In this manner terminates the cord of the sympathetic nerve.

[1] Mr. T. Snow Beck on the Nerves of the Uterus; being a very valuable paper on the origin and distribution of the lower portion of the sympathetic. Philos. Transactions, London, 1846.

CHAPTER III.

OF THE NERVES OF THE MEDULLA SPINALIS.

The nerves of the medulla spinalis, with the exception of the first, which, from its position, is generally called by anatomists the suboccipital, are arranged into cervical, dorsal, lumbar, and sacral, according to the order of the intervertebral foramina, through which they pass out; but a much better division would be Cervical,[1] Thoracic, and Abdominal. Their mode of origin, and the ganglions formed by them, have been pointed out in the account of the medulla spinalis.

SECT. I.—OF THE UPPER NINE SPINAL NERVES.

These are spent upon the neck, upon the upper extremities, and upon the diaphragm. They consist in the Suboccipital Nerve, the Seven Cervical, and the First Dorsal.

Of the Suboccipital Nerve.

The Suboccipital Nerve (*nervus infra-occipitalis, decimus cerebri*) is one of the smallest that proceeds from the medulla spinalis. It has the peculiarity, generally, of arising by a single root, which comes from the anterior cord of the medulla spinalis, between the occiput and the first cervical vertebra. This root consists of from two to six or seven fasciculi, situated one above another. When the posterior root exists, it is very small, is composed of from one to three fasciculi, and anastomoses with the accessory nerve.

The trunk of this nerve passes from the vertebral cavity through the foramen formed in the dura mater by the vertebral artery; it goes out below the latter, and between the occiput and the first vertebra, behind its superior oblique process. It there forms a small long ganglion, like the other spinal nerves, and then divides into an anterior and a posterior fasciculus.

The anterior fasciculus is the smaller of the two; it follows, in some measure, the course of the vertebral artery, and going forwards to the front of the transverse process, is then divided into several fine filaments, some of which go to the contiguous muscles on the front of the vertebræ; others join themselves to the pneumogastric and hypoglossal nerves, and to the superior cervical ganglion of the sympathetic; others anastomose with the first cervical nerve.

The posterior fasciculus runs backwards, and is distributed to the recti and the obliqui muscles on the back of the neck, and to the com-

[1] In this case the term Cervical would include the first eight.

plexus. A cutaneous branch from the suboccipital nerve is sometimes found, and attends the occipital artery.[1]

Of the Cervical Nerves.

These are seven in number: the first one gets from the spinal cavity between the atlas and the dentata; and the last between the seventh cervical and the first dorsal vertebra. After the ganglion is formed upon the posterior fasciculus of each, the trunk, made by the union of the two fasciculi, divides almost immediately again into an anterior and a posterior trunk.

Of the First Cervical Nerve.

The posterior trunk is the largest, and goes directly backwards. It has its filaments distributed to many of the muscles on the upper posterior part of the cervical vertebræ, and to the integuments of the part. Some of the branches ascend through the muscles, near the occiput; and, rising up on the latter, are distributed upon its integuments, and upon the occipito-frontalis muscle.

The anterior trunk is directed forwards under the inferior oblique muscle of the neck, and then divides into two branches: the superior joins the anterior branch of the suboccipital nerve, and anastomoses with the first cervical ganglion of the sympathetic, with the par vagum, the spinal accessory, and the hypoglossal nerve; the inferior joins the anterior branch of the second cervical nerve.

Of the Second Cervical Nerve.

This nerve issues between the second and the third cervical vertebra. Its posterior trunk is spent upon the trapezius, complexus, and other muscles on the back of the neck, and upon the integuments of the latter; it also anastomoses with the posterior trunk of the nerve above and below.

The anterior branch or trunk detaches, first of all, some small filaments to the muscles on the front of the cervical vertebræ; it then divides into two principal fasciculi, one of which ascends and the other descends.

The ascending branch goes upwards and backwards, and early in its course anastomoses with the first cervical nerve, thereby forming with it a nervous noose; it then mounts upon the occiput, and is distributed upon the parts on the latter region, anterior to the occipital branches of the preceding nerve.

The descending branch turns over the posterior margin of the sterno-cleido-mastoideus muscle, and gives filaments to it. It is distributed afterwards by branches, some of which go to the integuments of the neck upon the angle and the base of the lower jaw (*nervi subcutanei colli superiores*), and one to the external ear (*nervus auricularis cervicalis*); others go to the integuments of the middle and inferior parts of the neck (*nervi subcutanei colli medii et inferiores*).

From the anterior fasciculus of the second cervical nerve, there pro-

[1] Sharpey and Quain, loc. cit. vol. ii. p. 298.

ceeds a filament downwards, which is the upper root of the phrenic nerve; another filament from it joins the superior cervical ganglion of the sympathetic.

Of the Third Cervical Nerve.

This nerve comes out between the third and the fourth cervical vertebra. Its posterior fasciculus is distributed to the muscles on the back of the cervical vertebræ, and to the integuments of the part; anastomosing, by its branches, with the nerve above and below.

The anterior fasciculus is larger than the posterior, and goes obliquely downwards and outwards at first; it sends anastomotic branches to the nerve above and below; it also anastomoses with the superior cervical ganglion of the sympathetic and with the descendens noni. One of its branches, on being joined by the branch just spoken of, from the second cervical nerve, constitutes the trunk of the phrenic nerve. But the principal number of its branches are distributed to the integuments along the clavicle (*nervi supra-claviculares*), the upper part of the sternum, and the shoulder; some of them going into the contiguous muscles, as the trapezius, subclavius, &c. Several anastomoses exist between the branches of this nerve and the terminating branches of the nervus accessorius.

The three preceding cervical nerves form, by their anastomoses with each other, a plexus, consisting in a number of large loops or arches, which lie upon the sides of the muscles connected with the transverse processes of the cervical vertebræ. There are commonly two series of anastomoses: the branches of the first series form the second series, and from the latter proceed, for the most part, the several branches which have been described. These anastomoses are covered by the upper half of the sterno-cleido-mastoid muscle, are involved in the cellular membrane surrounding the great vessels of the neck, and are covered by the lymphatic glands. Their intertexture and distribution are such that no adequate idea of them can be conveyed without dissection. From this plexus several branches go to the sterno-mastoid muscle; it is united above to the suboccipital nerve, and below to the fourth cervical.

Besides the preceding or anterior plexus, there is another, called the posterior cervical plexus, which is found in the midst of the muscles on the back of the neck, being derived from the posterior fasciculi. The terminating filaments go, as stated, to the muscles and integuments of the part.

Of the Phrenic Nerve.

The Phrenic Nerve (*nervus phrenicus, diaphragmaticus*), or the Internal Respiratory of Bell, arises, in the manner stated above, from the anterior fasciculus of the second and of the third cervical, and is assisted generally by two or three filaments from the upper part of the brachial plexus. It descends, vertically, on the humeral side of the internal jugular vein, but removed a considerable distance from it, and is attached, by cellular substance, to the front of the scalenus anticus

muscle. Getting, in its descent, to the internal margin of the latter, it passes into the thorax, at the inner margin of the first rib, between the subclavian artery and the subclavian vein, the latter being before it. It then goes along the superior mediastinum to the pericardium, to the side of which it adheres in front of the root of the lung, being between the pericardium and the corresponding portion of the pleura; it finally reaches the diaphragm, to which it is distributed.

Just before the phrenic nerve reaches the diaphragm, it radiates into several branches, which interchange filaments. Some of the branches are distributed to the convex surface of the diaphragm; others penetrate this muscle, and are distributed in its thickness and upon its concave surface. On the right side, some of these branches pass through the opening for the ascending vena cava, and thus, getting into the abdomen, anastomose with the solar plexus, and with the pneumogastric nerve.

The phrenic nerve of the left side is nearer to the root of the lung than that of the right, in consequence of the projection of the apex of the heart on that side. Its distribution in other respects does not present any remarkable difference from the other; its branches radiate in the same way to the diaphragm, and supply its thickness, as well as its upper and under surfaces. It sends some filaments to the lower part of the œsophagus.

The phrenic gives off in the neck a few filaments to the scalenus anticus, and the rectus anticus major muscle. It also communicates there with filaments from the inferior cervical ganglion, and sometimes from the superior cervical.

Of the Four Inferior Cervical Nerves.

The trunks of these nerves, on issuing from the intervertebral foramina, have one general mode of distribution, which permits them to be described together or in common.

The posterior branches are much smaller than those of the preceding cervical nerves; they go backwards between the complexus and the transversalis colli, and leave filaments in their passage with them and other muscles: they then reach the splenius and the trapezius, to which and to the integuments of the neck they are distributed. Like the upper, they also anastomose or form a plexus as they pass on to their destination.

The anterior branches are large; they appear on the side of the neck, between the scalenus anticus and medius muscles; sometimes perforating the substance of one or the other of these muscles. They each detach filaments to the sympathetic. The fourth, also, commonly sends one to the phrenic. They then form the Brachial Plexus.

Of the Brachial Plexus and the Nerves of the Upper Extremity.

The Brachial or the Axillary Plexus is formed by the junction and the intertexture of the four inferior cervical nerves, and the first dorsal or thoracic. It extends from the scaleni muscles to the axilla, on a level with the neck of the os humeri. The nerves at first converge,

and are situated somewhat behind the subclavian artery where it passes over the first rib: but are at various heights above it according to their origin, with the exception of the first dorsal nerve, which has to ascend in order to pass out of the thorax.

The plexus is formed in the following manner: The fourth and the fifth cervical nerves unite near the scaleni muscles into a single trunk, which runs a short distance downwards, and then splits into two. The seventh cervical and the first dorsal do the same. The sixth cervical is the central nerve of the plexus, and after going downwards two or three inches, it bifurcates also. Combinations of these primary divisions are formed, which are dissolved, and then re-formed in such a way that a complex intertexture of the original nerves takes place. This intertexture surrounds the axillary artery somewhat like the braids of a whip-cord, from the clavicle to the os humeri below its head. In this course the axillary plexus passes along with the artery between the subclavius muscle and the first rib, lies in contact with the superior part of the serratus major anticus muscle, and immediately below the articulation of the shoulder joint. The axillary vein is in front of it.

The nerves which proceed from the axillary plexus are the Supra-Scapular; the Subscapular; the Thoracic; the Axillary; the two Cutaneous; the Radial; the Ulnar; and the Median. They supply the superior extremity, including the shoulder and the axilla.

1. The Supra-Scapular Nerve (*nervus supra-scapularis* or *scapularis*) is a small branch coming commonly from the upper part of the plexus, as formed by the fourth cervical nerve. It goes backwards in company with the arteria dorsalis superior scapulæ, through the notch or foramen of the upper costa of the scapula; and having thus got to the posterior face of the latter, it gives filaments to the supra-spinatus muscle; continuing its course then on the posterior face of the cervix scapulæ, it is lost in filaments upon the infra-spinatus and teres minor muscles.

2. The Subscapular Nerves (*nervi subscapulares*) of Bichat present some varieties in their origin; occasionally they come from the same trunk, but commonly each has its peculiar root from the central parts of the axillary plexus. There are generally three of them. One of them descends behind the axillary vessels, between the subscapularis muscle and the serratus major anticus; it crosses the teres major, and is lost upon the contiguous part of the latissimus dorsi. Another is distributed upon the subscapularis muscle. The third descends along the anterior margin of the subscapularis for a short distance, and distributes filaments to it, to the teres minor and major muscles.

3. The Thoracic Nerves (*nervi thoracici exteriores*) are primarily two or three in number, and proceed from about the middle of the plexus. They may be distinguished as anterior and posterior. The former are distributed by filaments to the subclavian muscle, to the pectoralis minor and major, and to the integuments covering the latter. The *Posterior thoracic* (*thoracicus longus*) has its origin somewhat concealed by the scalenus anticus muscle. It descends into the axilla, adhering

to the serratus major muscle for some distance, and is then distributed by many filaments to this muscle. This is the external respiratory of Bell.

4. The Axillary or Circumflex Nerve (*nervus axillaris, circumflexus*) comes from the inferior part of the plexus. Immediately after its origin, it goes downwards and outwards over the upper extremity of the subscapularis muscle. It then winds around the os humeri, between the teres minor and major muscles, observing the course of the posterior circumflex artery, and, finally, terminates on the under surface of the deltoid muscle.

This nerve sometimes gives off the subscapular nerves, and, indeed, it is usual for anatomists to include the description of the latter in it. As it turns round the bone, it divides into two principal trunks; the superior goes to the inferior margin of the infra-spinatus and to the posterior margin of the deltoides; the inferior is distributed principally in the substance of the deltoid muscle, but some of its filaments, by perforating the latter, reach the skin, and constitute the *Nervus cutaneus humeri.*

Fig. 311.

Brachial Plexus of Nerves.—1, 1. The scalenus anticus muscle. 2, 2. The median nerve. 3. The ulnar nerve. 4. Filaments to the brachialis internus and to the biceps muscle from the musculo-cutaneous nerve. The belly of the biceps has been cut away. 5. The exterior thoracic nerves. 6. The phrenic nerve.

Filaments go from the nervus axillaris, in the early part of its course, to the subscapularis and the two teres muscles.

5. The Internal Cutaneous Nerve (*nervus cutaneus internus*[1]) arises

[1] Antonius and Caldani, tabul. cclviii.

from the lower part of the axillary plexus, and is one of the smallest of those which go to the arm. It is situated between the median and the ulnar nerve, and adheres almost as far as the elbow to the basilic vein. In its descent, this nerve detaches several small filaments, which, perforating the fascia of the arm, are distributed to the integuments of the biceps muscle, and to those on the internal face of the triceps.

Somewhat above the bend of the elbow, at the place where the median basilic vein joins the basilic, but occasionally some inches higher up, the internal cutaneous becomes superficial, and splits into two branches of nearly equal magnitude, which diverge but little from each other at first. The branch nearest the internal condyle of the os humeri lies in front of the basilic vein, as it passes over the elbow joint; and continues in this position for two or three inches: it goes down the front of the fore arm on its ulnar side, but inclines continually to the back of the fore arm. In this course, it detaches small ramifications to the integuments about the internal condyle, and about the heads of the flexor muscles; it also detaches continually, from its sides, small filaments to the integuments of the ulnar side of the fore arm both anteriorly and posteriorly, some of which reach to the hand. The other, being the anterior, or the external branch of the internal cutaneous, which is nearer the radius, passes beneath the median basilic vein, about six lines from the basilic; but, just before it does so, it detaches a very superficial cutaneous filament, which crosses in front of the median basilic vein about its middle, and is lost a little below the bend of the arm. The anterior or outer branch of the internal cutaneous having got from beneath the median basilic vein, goes superficially as far as the middle of the fore arm without sending off any filaments of note; it is then divided successively into several, which diverge to supply the skin down to the wrist.

A nerve of some size, called the small internal cutaneous (*nervus Wrisbergii*), arises either from the root of the cutaneus internus or from the brachial plexus near it. It pierces the brachial fascia at or near the middle of the arm, and then goes down so as to take a position between the olecranon and the internal condyle. It communicates with the first intercosto-humeral nerve, and its terminal filaments go to the integuments on the back of the arm and of the fore arm between those of the external and internal cutaneous.

6. The Musculo-Cutaneous Nerve, External Cutaneous (*nervus musculo-cutaneus, cutaneus externus*), is somewhat larger than the preceding, and arises from about the middle of the brachial plexus. It descends a short distance, and then perforates obliquely the upper part of the coraco-brachialis muscle. Having passed through this muscle, it continues its course obliquely, between the brachialis internus and the biceps flexor, and finally makes its appearance superficially on the outer side of the tendon of the latter. In this course, it distributes filaments to the several muscles with which it is connected.

It afterwards passes the elbow joint under the median cephalic vein near its middle, and descends between the skin and the fascia of the fore arm, near the outer margin of the median vein, to the hand: in this course, it is parallel with and on the front of the supinator radii

longus. It distributes many filaments to the corresponding integuments on the radial side of the fore arm, and, having at length got near the lower end of the radius, it divides into two orders of filaments, one of which is distributed to the integuments on the dorsal, and the other to those on the palmar side of the hand, about the root of the thumb.

7. The Radial or Muscular Spiral Nerve (*nervus radialis, musculo-spiralis*) arises from the upper portion of the brachial plexus, but in such a way that filaments from almost every part of the latter run into it. It is a large trunk which winds spirally around the os humeri, between the triceps muscle and the bone, by entering the fissure between the first and the third head of the triceps. It appears on the outside of the os humeri, between the brachialis internus and the triceps muscle; running for some inches in contact with their intermuscular ligament. While beneath the triceps, it sends several branches to its heads. There are three principal trunks afterwards from this nerve.

Fig. 312.

Nerves on the front of the Fore Arm and Hand.—1. The median nerve. 2. Ramus superficialis anterior of the radial nerve. 3. The ulnar nerve. 4. Division of the median nerve in the palm to the thumb, first, second, and radial side of the third finger. 5. Division of the ulnar nerve to the ulnar side of the third and both sides of the fourth finger.

a. The Ramus Superficialis Dorsalis is sent from it on a line with the point of the deltoid muscle. This branch then goes just below the

skin, parallel with and over the external ridge of the os humeri; it, of course, crosses the origin of the muscles of the external condyle. It continues superficial on the posterior external edge of the supinator radii longus muscle, and terminates in the integuments on the back of the hand.

The continued trunk of the muscular spiral goes in the interstice between the extensor muscles, and the brachialis internus, and, at the external condyle, divides into the other two branches, from which filaments proceed to the contiguous heads of the muscles.

b. The Ramus Profundus Dorsalis perforates the supinator brevis muscle, getting beneath the radial extensors to the back of the fore arm; it is then distributed in numerous filaments to the muscles on the back of the fore arm, some of its branches reaching to the wrist.

c. The Ramus Superficialis Anterior seems to be a continuation of the main trunk of the nerve, and descending at the anterior margin of the supinator radii longus muscle, it joins with the radial artery, and continues in its company to a short distance below the middle of the radius.[1] Here it crosses the bone obliquely beneath the tendon of the supinator longus, and then divides into a palmar and a dorsal ramuscule: the first being distributed to the muscles and integuments of the thumb, the second terminating so as to supply the back of the hand, of the thumb, fore, middle, and ring fingers to their extremities.

8. The Median Nerve (*nervus medianus*) descends the arm at the inner edge of the biceps muscle, along the anterior surface of the brachial artery, adhering firmly to it, and the deep-seated veins, by cellular substance. As far as the elbow, it sends off no branch of importance. There it lies at the side of the biceps tendon, crosses the lower part of the brachialis internus, and is beneath the aponeurosis of the biceps. It then perforates the pronator teres and gets between the flexor sublimis digitorum, and the flexor longus pollicis, and enters the palm of the hand under the ligament of the wrist, at the radial edge of the tendons of the flexor sublimis. In the palm it is situated beneath the aponeurosis palmaris and the arcus sublimis of the arteries.

The median nerve dispenses the following branches: At the bend of the arm, it furnishes filaments to the heads of the first layer of muscles of the fore arm; and a little below, it detaches the Nervus Interosseus, which supplies filaments to the flexor longus pollicis and flexor profundus digitorum. The interosseous nerve then descends with the interosseous artery, in front of the interosseous ligament, and terminates in the pronator quadratus, but sometimes its filaments reach the back of the wrist.

Before the median nerve reaches the wrist, it sends a branch which supplies with filaments the muscles and integuments of the ball of the thumb. In the palm of the hand, besides the filaments to interosseous and lumbricales muscles, it divides and subdivides so as to send a branch to each side of the thumb, of the fore, and of the middle finger, and to one side of the ring finger. These branches go along with the arteries to the ends of the fingers and thumb.

[1] This position gives the whole nerve the name of Radial.

9. The Ulnar Nerve (*nervus ulnaris*) comes from the lowest section of the brachial plexus. It descends along the internal anterior part of the triceps muscle, in a groove formed between it and the intermuscular ligament: it diverges in this course gradually from the median nerve till it reaches the elbow, when it is at its greatest point of separation. At the elbow, it is behind the internal condyle, in the groove between it and the olecranon, and separates the two heads of the flexor ulnaris muscle. It then gets to the fore arm between this muscle and the flexor profundus digitorum, supplies them, and continues between them to within two inches of the wrist joint, when it detaches the Ramus Dorsalis.

Fig. 313.

Nerves on the back of the Fore Arm and Hand.—1, 1. The ulnar nerve. 2, 2. The ramus profundus dorsalis of the radial nerve. 3. The ramus superficialis dorsalis of the radial nerve. 4. The dorsal branch of the ramus superficialis anterior of the radial nerve. 5, 5. A back view of the digital nerves. 6. Ramus dorsalis of the ulnar nerve.

The Ramus Dorsalis dips between the ulna and the tendon of the flexor ulnaris, runs along the internal margin of the ulna to the carpus; it then divides into ramuscules, which supply the ulnar side of the integuments on the back of the hand, and on the backs of the last two fingers. At the interval behind, between the heads of the metacarpal bones of the middle and ring fingers, a considerable ramuscule joins one from the branch of the muscular spiral nerve, which attended the radial artery.

The Ulnar Nerve, having given off this dorsal branch, descends along the radial margin of the tendon of the flexor ulnaris and the os pisiforme, above the annular ligament, to the palm of the hand. Getting beneath the aponeurosis, it there detaches first a deep-seated branch (*ramus profundus*), in connection with the cubitalis manus profunda artery, and penetrates the muscles of the little finger to supply them, the adjoining lumbricales and interossei, and the short flexor, and the adductor of the thumb. The ulnar nerve then furnishes a superficial branch to the palmaris brevis muscle and adjoining integuments, and afterwards divides into three; one for the ulnar side of the little finger, another for the opposing sides of the little and ring finger, and a third which joins the most internal digital branch of the median nerve.

Attached to some of the nerves, as the cutaneous, and also to the solar plexus, but in an especial degree to the digital branches in the hands and feet, are numerous small bodies, called from their discoverer Pacinian.[1] They are of an elliptical shape, appended by a pedicle; are about a line long and half a line wide; and consist in a series of capsules from forty to sixty, one within the other, with a cavity in the central one. Each corpuscle is furnished with a nervous filament reaching it through the pedicle, and coming to a single or bifid end in the central cavity. They are considered by their discoverer as electrical organs.

SECT. II.—OF THE THORACIC SPINAL NERVES.

The Dorsal or Thoracic Spinal Nerves (*nervi thoracici dorsales*) consist in twelve pairs; the first pair goes through the intervertebral foramen, between the first and the second dorsal vertebra, and the twelfth pair between the last dorsal and the first lumbar vertebra. The common trunk formed after the ganglion of each nerve goes but a short distance when it divides into an anterior and a posterior branch.

The Posterior Branch (*ramus dorsalis*) of each nerve goes backwards between the transverse processes of the corresponding vertebræ, and, having got beneath the multifidus spinæ, is commonly subdivided into internal and external ramuscules. The internal are the smaller, and are distributed upon the muscles lying upon the spine, as the multifidus, the sacro-lumbalis, longissimus dorsi, and so on: their terminating filaments reach the skin. The external branches descend obliquely outwards beneath the longissimus dorsi, and then issue between the latter and the sacro-lumbalis, to both of which they dispense filaments: they afterwards are divided into branches which go to the trapezius, latissimus dorsi, rhomboideus, and to the corresponding integuments.

The Anterior Branches of the Dorsal Nerves (*rami subcostales*)

[1] Discovered in 1830. See Nuovi organi scoperta, &c., da Felipo Pacini, 1840. Henlé and Kolliker on the Pacinian Corpuscles, Zurich, 1844. Br. and For. Med. Review, January 1845.

correspond with the intercostal spaces of the ribs. Each one, in a short course after its origin, applies itself to the rib just above it, and accompanies the intercostal vessels in the groove, formed in the under margin of each rib. After it proceeds about one-half or two-thirds of the length of the rib, it separates gradually from it, and goes nearer the middle of the intercostal space, and the superior margin of the rib below. To the angle of the rib, each nerve is only covered in front by the pleura, but afterwards it goes between the intercostal muscles. Near the sternum, the branches become superficial by escaping from between the intercostal muscles, and are distributed upon the pectoral muscles and the adjacent skin. These terminating branches of the five or six inferior thoracic nerves go to the upper portions of the abdominal muscles and their integuments. Not far from its origin, each dorsal nerve anastomoses with the ganglion or cord of the sympathetic, after the manner described in the account of the latter nerve.[1]

There are some differences between the thoracic nerves in their manner of distribution.

The anterior fasciculus of the First, as mentioned, forms the lower part of the axillary plexus by joining itself to the seventh cervical. It sends out, however, a subcostal branch which goes along the inferior face of the first rib, supplying its intercostal muscles and having the general distribution alluded to.

The Second Subcostal Branch or Nerve, besides the common distribution, detaches a fasciculus, which, penetrating between the ribs, gets into the axilla, and is augmented by a branch (the nerve of Wrisberg), from the internal cutaneous nerve of the upper extremity. It then descends along the internal posterior face of the arm to the elbow, and in this course detaches several fine filaments to the integuments.

The Third Subcostal Branch, or Nerve, in like manner detaches an axillary fasciculus which goes to the inferior part of the arm-pit, to the integuments of which, and to those on the internal face of the arm, it is distributed. It does not descend quite so low as the preceding. These two nerves are called *Intercosto-Humeral*, and from their origin and course, are supposed to account for the numbness of the arm, in cases of Angina pectoris.

The Fourth, Fifth, Sixth, and Seventh Subcostal Branches of the Dorsal or Thoracic nerves, about the middle of the ribs to which they respectively belong, are all divided into two branches. One of them, which is properly speaking the *intercostal*, continues in the intercostal space, giving filaments to its muscles and to the triangularis sterni; it then emerges near the sternum to terminate upon the great pectoral muscle, the mamma, and the integuments of the front of the thorax. The other branch is the *external pectoral:* it extricates itself earlier

[1] In pleuritis there is a deposit of lymph mixed with the cellular adipose matter surrounding the Sympathetic, its costal branches, and the subcostal nerves until the latter get between the intercostal muscles. This inflamed state must, no doubt, produce particular nervous phenomena; as pain, difficulty of respiration, and derangement of the functions of the abdominal viscera.

from the intercostal space, and is distributed upon the muscles and the integuments on the side of the thorax.

The remaining Subcostal Nerves, to the eleventh inclusively, have very much the same principle of distribution. Their intercostal fasciculi, having reached the anterior ends of the intercostal spaces, pass on to the abdominal parietes, between the transversalis muscle and the internal oblique, to both of which they give filaments. They reach the external margin of the rectus abdominis muscle, and then divide into filaments, some of which go to this muscle, others pierce the fore part of its sheath, and are ramified upon the integuments of the front of the abdomen.

The Twelfth Subcostal Branch of the Dorsal Nerves sends first a branch downwards, which joins with the first lumbar nerve. It then crosses in front of the quadratus lumborum muscle, to which it gives filaments as well as to the adjoining portion of the diaphragm. It afterwards divides into two branches, the superior of which goes for some distance between the two oblique muscles of the abdomen, detaching filaments to them, and finally terminates on the integuments of the abdomen. The other branch goes between the transversalis and the internal oblique, and is extended to the lower part of the rectus, and to the pyramidalis muscle, to all of which it distributes filaments. One of its divisions becomes superficial, crosses the anterior part of the crest of the ilium, and is disposed of upon the gluteal integument as low down as the trochanter major.

SECT. III.—OF THE ABDOMINAL SPINAL NERVES.

There are five lumbar, and five, sometimes six, sacral nerves on each side; the first of them passes out of the intervertebral foramen, between the first and the second lumbar vertebra; and the remaining lumbar and sacral nerves go, successively, through the foramina in the loins and in the sacrum.

The anterior fasciculi of these nerves form a plexus which extends from the upper part of the loins to the lower part of the sacrum: it is designated under the general term of Plexus Cruralis. The posterior fasciculi are much smaller. Those of the loins go backwards between the transverse processes, and are distributed upon the sacro-lumbalis, the longissimus dorsi, the multifidus spinæ, and the corresponding integuments. The posterior fasciculi of the sacral nerves are not so large, generally, as those of the lumbar: they get out through the foramina, on the posterior face of the sacrum; are distributed to the same muscles, to the origin of the glutæus magnus, and to the integuments of the sacrum, and of the adjoining portion of the buttocks.

The Plexus Cruralis, for the purpose of description, has been divided by anatomists into the Plexus Lumbalis, formed by the four superior lumbar nerves, and the Plexus Ischiadicus, formed by the last lumbar and the sacral nerves.

The Lumbar Plexus (*plexus lumbalis*) is concealed by the psoas magnus muscle, and is placed between it, the lumbar vertebræ, and the quadratus lumborum. Frequently the roots of the nerves forming

this plexus penetrate through the substance of the psoas magnus, and form their unions in it. The plexus is narrow and pointed above, where it commences by the fasciculus of the last dorsal nerve joining the first lumbar; but it increases continually afterwards in breadth, owing to the nerves composing it, successively anastomosing farther and farther from the spinal column. From this plexus proceed three principal trunks: the upper one, the Anterior Crural (*cruralis anterior*), is of considerable size, and goes to the skin and the muscles on the front of the lower extremity; the middle, called Obturator (*nervus obturatorius*), is not so large as the preceding, and goes through the obturator foramen to the adductor muscles of the thigh; the inferior, formed by the whole of the fifth and a fasciculus from the fourth lumbar nerve, joins the upper part of the Plexus Ischiadicus in the pelvis. Besides these, there are several branches of smaller size and of less importance, proceeding from the lumbar plexus. As follows:—

Fig. 314.

The Lumbar Plexus and its Branches (slightly altered from Schmidt).—*a*. Last rib. *b*. Quadratus lumborum muscle. *c*. Oblique and transverse muscles, cut near the crest of the ilium. *d*. Os pubis. *e*. Adductor brevis muscle. *f*. Pectineus. *g*. Adductor longus. 1. Abdomino-crural nerves. 2, 3. External cutaneous. 4. Anterior crural nerve. 5, 6. Obturator nerve and branches. 7. Spermaticus externus. 8. Gangliated cord of the sympathetic nerve.

The *Abdomino-Crural Branches* (*nervi ilio-hypogastrici*), according to Bichat, are most commonly three in number, and come from the two upper lumbar nerves. The first of them goes obliquely downwards and outwards, in front of the quadratus lumborum, to the posterior part of the spine of the ilium, and runs for a short distance

along the crista of the bone: it gives filaments to the iliacus internus, and to the abdominal muscles, where they border upon this part of the bone. Some of the filaments become cutaneous, but the main trunk of the nerve reaches the anterior superior spinous process, by going between the transversalis and the internal oblique muscle; it then follows the inguinal arch to the external ring, through which it passes, and is distributed in filaments upon the groin, the pubes, and the scrotum. The second or middle branch arises from the plexus near the preceding; it descends along the external margin of the psoas magnus, and crosses the iliacus internus, covered by the peritoneum; near the anterior superior spinous process, it gets between the lower margins of the abdominal muscles, and is distributed upon them there; some of its ramifications get also through the external ring, and may be traced to the scrotum. The third, or the inferior branch, arises from the plexus still lower down, and, after having traversed the front of the iliacus internus, it emerges from the pelvis beneath Poupart's ligament, near the anterior superior spinous process; it then divides into filaments which penetrate to the skin through the femoral fascia, and are distributed along the external anterior face of the thigh.

The External Spermatic (*spermaticus externus*, *ilio-inguinalis*) which arises from the upper part of the plexus, by a fasciculus from the first lumbar nerve, which is increased by one from the second lumbar. It descends at first in the body of the psoas magnus muscle and then in front of it: it crosses the iliacus internus, somewhat above Poupart's Ligament, by directing its course towards the anterior superior spinous process of the ilium. Here, it involves itself in the edge of the abdominal muscles, and goes on the posterior face of Poupart's Ligament. At the internal abdominal ring it joins the spermatic chord of the male, or the round ligament of the uterus of the female. In the first case, it is distributed to the spermatic chord and scrotum; in the second, to the labium externum and mons veneris.

The External Cutaneous (*cutaneus externus*), which arises from the lumbar plexus below the external spermatic, passes across the iliacus internus towards the anterior superior spinous process, about an inch below the spermaticus externus, and crosses the latter nerve just at that process. Emerging from the abdomen, by penetrating the commencement of Poupart's Ligament, it is distributed in several branches to the integuments of the vastus externus muscle, and along the edge of the rectus femoris: one of the latter extends to the patella.

The preceding nerves are subject to variations from the account given.

The Middle Cutaneous (*cutaneus medius*) is detached from the Anterior Crural, an inch or so above Poupart's Ligament. It arises among the cluster of branches which comes off there to be distributed to the iliacus internus muscle and to the muscles of the thigh. It appears superficially, on the thigh for the first time, by penetrating the sartorius muscle about the internal edge of the rectus femoris; it descends then along the same edge of the latter muscle, and is distributed to its integuments. It does not descend so low as the external cutaneous.

The Anterior Cutaneous (*cutaneus anterior*) arises, also, from the anterior crural nerve. It is on the inner side of the cutaneus medius, emerges from the fascia of the thigh, and crosses the sartorius muscle two or three inches below the cutaneus medius. It is distributed on the integuments of the vastus internus muscle, and some of its branches extend to the internal edge of the patella.

The Internal Cutaneous (*cutaneus internus*) arises from the anterior crural nerve, among the same cluster, above Poupart's Ligament. It divides into four or five branches of different lengths, and is distributed

Fig. 315.

Anterior Crural Nerve and its Branches.—1. Point where the nerve comes out under Poupart's ligament. 2. Division of the nerve and its branches. 3. The femoral artery. 4. The femoral vein. 5. Branches of the obturator nerve. 6. The nervus saphenus.

to the integuments of the adductor muscles, and along the inner front side of the thigh. One branch observes very much the course of the tendon of the adductor magnus, and reaches as far down as the inner side of the knee.

The Anterior Crural (*cruralis anterior*) arises from the middle of the

lumbar plexus: at first, it is beneath the psoas magnus muscle; it then gets to its outside, and passes from the abdomen, under Poupart's Ligament, about half an inch from the outside of the femoral artery. Before it reaches Poupart's Ligament, it gives off a cluster of nerves, several of which go to the iliacus internus muscle; others form the superficial or cutaneous nerves of the thigh just mentioned; and others, the deep-seated or muscular branches, which supply the adductor muscles of the thigh, its four extensors, the pectineus, the sartorius, and the gracilis.

One of the branches of the anterior crural nerve is seen to accompany the femoral artery, till the artery penetrates the adductor magnus; it then runs along the front margin of the tendon of the adductors in a theca formed by this tendon and the origin of the vastus internus. The nerve alluded to is the *Saphenous* (*saphenus externus*); it passes afterwards between the internal condyle of the os femoris and the sartorius muscle, attaches itself to the saphena vein, and is distributed to the integuments of the inner side of the leg, and of the upper internal parts of the foot.

The Obturator (*nervus obturatorius*) is derived from the middle of the lumbar plexus, also; and has very much the same position, in regard to the psoas magnus, as the anterior crural nerve. It descends into the pelvis from beneath the psoas magnus, near the sacro-iliac articulation; and passes forwards and downwards to the obturator foramen; having got through which, it divides into an anterior and a posterior branch. The first is distributed to the head of the adductor longus and brevis, and to the gracilis and integuments. The second terminates in the obturator externus, and the adductor magnus.

The Sciatic Plexus (*plexus ischiadicus*) is formed by the union of the last lumbar with the four upper sacral nerves; the last lumbar, before it joins the plexus, receives the branch of the fourth lumbar nerve, which is left after the lumbar plexus is formed. This plexus is situated at the side of the rectum before the pyriformis muscle.

The volume of the posterior branches of the Sacral Nerves increases till the fourth; but the fifth and sixth are much smaller, in fact only fibrillæ.

The anterior branches of the sacral nerves are much larger than the posterior. The first four communicate with the sacral ganglia of the great sympathetic, besides forming the sciatic plexus. They assist the sympathetic, to form the hypogastric plexus. The fifth, and the sixth when it exists, are distributed to the coccygeus, sphincter, and levator ani.

The following small branches go from the Sciatic Plexus:—[1]

[1] This is only given as the most frequent arrangement of the Sciatic plexus, and of the branches of nerves which proceed from it; other arrangements will often be met with in the cavity of the pelvis, in which not so many sacral nerves are sent to the plexus ischiadicus; and the several branches proceeding from it depart in a different manner.

The small branches described sometimes come from a common trunk, called, in such case, the Small Sciatic.

The Gluteal Nerves (*nervi glutæi*): one (*glutæus superior*) passes through the upper part of the sciatic notch along with the gluteal artery, to the glutæus medius and minimus muscles; another (the *glutæus inferior*) below the pyriformis muscle to the glutæus magnus.

The Internal Pudic Nerve (*nervus pudendalis longus superior*) comes from about the third and fourth sacral. It goes in company with the internal pudic artery between the sacro-sciatic ligaments, and then divides into two branches; the inferior is distributed to the integuments and muscles of the perineum, to the urethra and scrotum; the superior, passing along the ramus of the ischium and pubes with the trunk of the internal pudic artery, is distributed to the obturator internus, accelerator urinæ, urethra, and afterwards, getting between the symphysis of the pubes and the penis, terminates on the integuments of the penis above, and on the glans penis.

The Perineal Nerve (*nervus pudendalis longus inferior*), when it exists (but it is frequently deficient as a distinct trunk, its branches being supplied by the last named nerve), passes under the tuber of the ischium to the glutæus magnus; perineal muscles; urethra and integuments of the penis and scrotum in men; and to the inferior parts of the labium externum in women.

The Posterior Femoral Nerve (*Ramus Femoralis Cutaneus Posterior, or Exterior*). This nerve is placed between the integuments of the thigh

Fig. 316.

A view of the Branches of the Ischiatic Plexus to the Hip and back of the Thigh.—1, 1. Posterior sacral nerves. 2. Nervi glutæi. 3. Nervus pudendalis longus superior. 4. Nervus pudendalis longus inferior, coming from the small sciatic. 5. The ramus femoralis cutaneus posterior. 6. Great ischiatic nerve.

and the muscles which arise from the tuberosity of the ischium. It sends many branches, successively, to the skin on the back of the

thigh; one of its branches, longer than the others, goes down to the ham, and there divides into several filaments, which are distributed to the integuments on the back of the leg.

The Great Sciatic (*nervus ischiadicus*) is the common trunk, formed from the sciatic plexus; it is much the largest nerve in the body, and passes from the pelvis between the pyriformis and the geminus superior. It crosses vertically the small rotator muscles of the thigh, being concealed by the inferior edge of the glutæus magnus; it is there about half way between the tuberosity of the ischium and the trochanter major. Thence it descends on the back of the adductor magnus, at the outer edge of the long head of the biceps flexor cruris. About half way down the thigh, sometimes a little lower, the Sciatic Nerve divides into the Popliteal, or Posterior Tibial, and the Peroneal. Occasionally this division takes place as high as the exit of the nerve from the pelvis; but in this case the fasciculi are parallel with each other as far as the middle of the thigh. From the trochanter minor to its usual place of division, this nerve is parallel with, and on the back of the thigh bone; afterwards the two branches begin to diverge. The popliteal nerve continues straight downwards to the back and middle of the knee joint, and to the interstice between the heads of the gastrocnemius muscle; whereas the peroneal nerve goes along the inner posterior edge of the biceps flexor cruris, and passes between its tendinous insertion and the external head of the gastrocnemius muscle.

In this course, the following branches are sent from the sciatic: Twigs to the little rotator muscles of the thigh. The *Cutaneus Internus Superior*, which arises near the upper part of the thigh, and is distributed to the skin of the corresponding part.—The *Cutaneus Internus Inferior*, which arises just below the last, and descending upon the inner head of the gastrocnemius, is distributed to the integuments of the calf of the leg.—A large trunk, and sometimes, instead of it, distinct branches which go to the Adductor magnus, Semi-membranosus, Biceps and Semi-tendinosus muscles.

The cutaneous nerves of the thigh are liable to great varieties in size, position, and exact point of origin, though they generally exist in some way.

A very common modification of the above distribution of nerves from the sciatic plexus, is for one nerve to pass from its upper part, being the gluteal nerve as described; for another nerve to pass from its lower part, emerge from the pelvis, go around the spinous process of the ischium, and return again through the lesser sciatic notch, and while there divide into two branches, the upper pudendal (*pud. long. super.*), and the lower pudendal (*pud. long. infer.*), which supply as indicated the parts connected with the perineum. The trunk from which these two come may be called the pudendal. (*Nerv. Pudend.*)

Then when the great sciatic nerve is free from the pelvis, a long branch is sent off, which represents all the cutaneous nerves of the thigh, for it passes straight down to the ham, and in its descent supplies nerve filaments to the integuments on the inner and outer side of the thigh from the buttock down to the knee.

The Peroneal Nerve (*Nervus Peroneus*) divides at the head of the

fibula into two branches, the Peroneus Externus and the Tibialis Anterior; but before this division, it sends a small branch to the external parts of the knee joint, and two cutaneous branches called Peroneo-Cutaneous. Of these the Internal Peroneo-Cutaneous descends behind

Fig. 317.

Nerves in front of Leg.—1. The external peroneal nerve. 2, 3. The anterior tibial nerve accompanying the artery of the same name.

the external head of the gastrocnemius, and, at the bottom of the leg, is united to a division of the posterior tibial called the External Saphenous, or Communicans Tibiæ. The External Peroneo-Cutaneous is distributed to the skin, along the fibula.

The External Peroneal Nerve (*peroneus externus*) gets between the head of the peroneus longus and the fibula, then between the peroneus longus and the extensor longus digitorum, leaving filaments to these several muscles as it goes along. It descends, at the outer edge of the last muscle, to the inferior third of the leg, giving out, in the mean time, many muscular branches. Here it penetrates the aponeurosis, and divides into cutaneous branches, which supply the lower part of

the leg, and the upper surface of the foot and toes. This nerve is called, by the French, the Musculo-Cutaneous of the leg.

The Anterior Tibial Nerve (*tibialis anterior*) gets obliquely between the fibula, the peroneus longus, and the extensor longus digitorum, to the front of the interosseous ligament, where it accompanies the anterior tibial artery. It passes, with the artery, under the annular ligament of the ankle, and has its terminating filaments going to the muscles and integuments of the upper surface of the foot, as far as the end of the first two toes. One of its branches sinks down with the anterior tibial artery to the sole of the foot. High up in the leg it sends filaments to the knee joint, and in its course downwards, it furnishes the muscles on the front of the leg.

Fig. 318.

Fig. 319.

Fig. 318. A view of some of the Branches of the Popliteal Nerve.—1. The popliteal nerve. 2, 3. Terminations of the ramus femoralis cutaneus posterior. 4, 5. The saphenous nerve. 6, 6. The external saphenous or communicans tibiæ.

Fig. 319. A view of the Posterior Tibial Nerve in the back of the Leg.—1, 2, indicate its course; the upper part of the peroneal nerve being seen to the right.

The Posterior Tibial, or Popliteal Nerve (*nervus popliteus*), having the direction mentioned, is placed between the skin and the popliteal vein. It gets between the heads of the gastrocnemius muscle, and perforates the origin of the soleus; going with the posterior tibial artery,

between this muscle and the flexor longus digitorum, to the bottom of the leg. It gives off the following branches:—

a. The External Saphenous (*saphenus externus*, or *communicans tibiæ*), which arises above the knee joint, and, descending between the skin and the gastrocnemius, turns outwardly, and anastomoses with the cutaneous branch alluded to of the peroneal nerve. The common trunk, thus formed, passes behind the external ankle, along the external margin of the foot, and terminates on the outer toes; having given off a great number of cutaneous branches.

b. Branches to the heads of the gastrocnemius, soleus, plantaris, and to the popliteus.

c. Branches to the flexor longus digitorum, tibialis posticus, and to the flexor longus pollicis pedis.

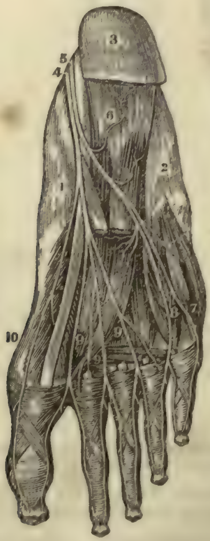
d. A branch through the interosseous ligament, above to the tibialis anticus.

e. At the inferior part of the leg many cutaneous filaments, one of which gets to the sole of the foot.

The Posterior Tibial Nerve, having given off these branches, divides, in the hollow of the os calcis, into the Internal and the External Plantar Nerve.

The Internal Plantar (*plantaris internus*) proceeds along side of the tendon of the flexor longus muscle of the great toe, and the flexor longus digitorum, and gives filaments to the contiguous muscles. It

Fig. 320.



A view of the termination of the Posterior Tibial Nerve in the Sole of the Foot.—1. Inside of the foot. 2. Outer side of the foot. 3. The heel. 4. Internal plantar nerve. 5. External plantar nerve. 6. Branch to the flexor brevis muscle. 7. Branch to the outside of the little toe. 8. Branch to the fourth and fifth toes. 9, 9, 9. Digital branches to the remaining toes. 10. Branch to the internal side of the great toe.

then divides in such a way as to furnish the two sides of the first three toes and the internal side of the fourth.

The External Plantar (*plantaris externus*) proceeds with the artery of the same name to the outer edge of the foot, between the flexor brevis digitorum and the flexor accessorius. It is distributed to the two sides of the little toe, and to the external side of the fourth toe. One branch penetrates to the interosseous muscles and to the transversalis pedis. A branch of considerable size is also detached, near the heel, to the muscles and integuments connected with the os calcis.

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